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FLUKE®

83,85,87

Multimeters

Service Manual

1000V CAT III IEC1010

FLUKE®

83,85,87

Multimeters

Service Manual

1000V CAT III IEC1010

PN 617826
January 1997
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Lifetime Warranty

Each Fluke 20, 70 and 80 Series DMM purchased after October 1, 1996 will be free from defects in material and workmanship for its lifetime. **Limitation**: This warranty does not cover fuses, disposable batteries and damage from accident, neglect, contamination, misuse or abnormal conditions of operation or handling, including overvoltage failures caused by use outside the DMM's specified rating, or normal wear and tear of mechanical components. This warranty covers the original purchaser only and is not transferable.

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11/96

MULTIMETER SAFETY

The Fluke 83, 85, and 87 Multimeters have been designed and tested according to IEC Publication 1010-1, Safety Requirements for Measurement, Control, and Laboratory use. This manual contains information and warnings that must be followed to ensure safe operation and keep the meter in safe condition. Use of this equipment in a manner not specified herein may impair the protection provided by the equipment.

These multimeters comply with part 15 of the FCC Rules. Operation is subject to the following two conditions: (1) these meters may not cause harmful interference, and (2) these meters must accept any interference received, including interference that may cause undesired operation.

Some common international electrical symbols are shown below:

	AC: ALTERNATING CURRENT	**CATIII**	Overvoltage installation category III. Fixed installations; industrial use.
	DC: DIRECT CURRENT		EARTH GROUND
	EITHER AC OR DC CURRENT		SEE EXPLANATION IN MANUAL
	FUSE		DOUBLE INSULATION FOR PROTECTION AGAINST ELECTRIC SHOCK

Before using the meter, read the following safety information carefully. In this manual, "Warning" is reserved for conditions and actions that pose hazard(s) to the user; "Caution" is reserved for conditions and actions that may damage your meter.

- Avoid working alone.
- Follow all safety procedures for equipment being tested.
- Inspect the test leads for damaged insulation or exposed metal. Check test lead continuity. Damaged leads should be replaced.
- Be sure the meter is in good operating condition.
- Select the proper function for your measurement.
- To avoid electrical shock, use caution when working above 60V dc or 30V ac rms.
- Disconnect the live test lead before disconnecting the common test lead.
- Disconnect the power and discharge high-voltage capacitors before testing in resistance and diodes or continuity.
- When making a current measurement, turn the circuit power off before connecting the meter in the circuit.
- Check meter fuses before measuring transformer secondary or motor winding current. An open fuse may allow high voltage build-up, which is potentially hazardous.
- Use clamp-on probes when measuring circuits exceeding 10 amps.
- When servicing the meter, use only the replacement parts specified.
- Do not allow the meter to be used if it is damaged or if its safety features are impaired.

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Chapter 1
Introduction and Specifications

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1-1. Introduction

This manual covers servicing information for Fluke multimeter Models 83, 85, and 87 that are marked with CAT III 1000V on the top case and CE on the bottom case. These markings indicate that the multimeter complies with IEC-1010 Category III, 1000V fuse rating. This service manual will prove useful for tasks ranging from routine maintenance to troubleshooting and repair. Specifications, theory of operation, calibration routines, testing and troubleshooting procedures, parts replacement information, and schematic diagrams are provided.

A meter under warranty will be promptly repaired or replaced (at Fluke's option) and returned at no charge.

1-2. Organization of the Service Manual

The following descriptions for the various sections serve to introduce the manual.

Section 1. Introduction and Specifications

This section describes both use of the Service Manual and application of special terminology (conventions) to describe the meter's circuitry. A complete set of specifications appears at the end of this section.

Section 2. Theory of Operation

This section first categorizes instrument circuitry into functional blocks, with a description of each block's role in overall operation. A detailed circuit description is then given for each block. These descriptions explore operation to the component level and fully support troubleshooting and repair procedures defined in Section 3.

Section 3. Maintenance

Provides complete maintenance information, from general maintenance and cleaning instructions to detailed troubleshooting and repair procedures to the component level. Troubleshooting and repair procedures rely closely on both the Theory of Operation presented in Section 2 and the Schematic Diagrams shown in Section 5.

Section 4. List of Replaceable Parts

Includes parts lists for all standard assemblies. Information on how and where to order parts is also provided.

Section 5. Schematic Diagrams

Includes schematic diagrams for all assemblies. A list of mnemonic definitions is also included to aid in identifying signal name abbreviations.

1-3. Conventions

Throughout the manual, certain notational conventions are used. A summary of these conventions follows:

- Instrument Reference

When the discussion involves common features of the Fluke 80 Series multimeters, the term "multimeter" is used, and the model number is not used. Where features differ among models, further identification is made by model number (Model 83, 85, or 87).

- Printed Circuit Assembly

  The term "pca" is used to represent a printed circuit board and its attached parts.

- Signal Logic Polarity

  Signal names followed by a "-" are active (or asserted) low. Signals not so marked are active high.

- Circuit Nodes

  Individual pins or connections on a component are specified with a dash (-) following the component reference designator. For example, pin 19 of U30 would be U30-19.

- User Notation

  Generally, buttons to be pressed, function positions to select, input terminals to use, and display notation to be read are presented in this manual as they are seen on the multimeter. However, one button on the Model 83/85 and two buttons on the Model 87 use no terminology and are identified by color (blue or yellow) in this manual.

  Special terms (mnemonics) used in text descriptions of multimeter circuitry correspond to terms used on the schematic diagrams in Section 5.

1-4. Specifications

Specifications for Models 83 and 85 are presented in Table 1-1. Model 87 specifications are presented in Table 2-2.

Table 1-1. Specifications, Models 83 and 85

Function	Range	Resolution	Accuracy[1]			
$\tilde{V}$ *			50 Hz - 60 Hz	45 Hz - 1 kHz	1 kHz - 5 kHz	
Fluke 83	400 mV	0.1 mV	±(1.0% + 4)	±(1.5% + 4)	±(2.0% + 4)	
	4.000V	0.001V	±(1.0% + 3)	±(1.5% + 3)	±(2.0% + 3)	
	40.00V	0.01V	±(1.0% + 3)	±(1.5% + 3)	±(2.0% + 3)	
	400.0V	0.1V	±(1.0% + 3)	±(1.5% + 3)	±(2.0% + 3)**	
	1000V	1V	±(1.0% + 3)	±(2.5% + 3)	unspecified	
$\tilde{V}$ *			50 Hz - 60 Hz	45 Hz - 1 kHz	1 kHz - 5 kHz	5 kHz - 20 kHz
Fluke 85	400 mV	0.1 mV	±(0.5% + 4)	±(1.0% + 4)	±(2.0% + 4)	±(3.0% + 4)
	4.000V	0.001V	±(0.5% + 2)	±(1.0% + 2)	±(2.0% + 2)	±(4.0% + 4)
	40.00V	0.01V	±(0.5% + 2)	±(1.0% + 2)	±(2.0% + 2)	±(4.0% + 4)
	400.0V	0.1V	±(0.5% + 2)	±(1.0% + 2)	±(2.0% + 2)**	unspecified
	1000V	1V	±(0.5% + 2)	±(1.0% + 2)	unspecified	unspecified
$\overline{\tilde{V}}$			Fluke 83		Fluke 85	
	4.000V	0.001V	±(0.3% + 1)		±(0.1% + 1)	
	40.00V	0.01V	±(0.3% + 1)		±(0.1% + 1)	
	400.0V	0.1V	±(0.3% + 1)		±(0.1% + 1)	
	1000V	1V	±(0.3% + 1)		±(0.3% + 1)	
mA⎓	400.0 mV	0.1 mV	±(0.3% + 1)		±(0.1% + 1)	
Ω	400.0Ω	0.1Ω	±(0.4% + 2)***		±(0.2% + 2)***	
	4.000 kΩ	0.001 kΩ	±(0.4% + 1)		±(0.2% + 1)	
	40.00 kΩ	0.01 kΩ	±(0.4% + 1)		±(0.2% + 1)	
	400.0 kΩ	0.1 kΩ	±(0.7% + 1)		±(0.6% + 1)	
	4.000 MΩ	0.001 MΩ	±(0.7% + 1)		±(0.6% + 1)	
	40.00 MΩ	0.01 MΩ	±(1% + 3)		±(1% + 3)	
(nS)	40.00 nS	0.01 nS	±(1% + 10)		±(1% + 10)	

Typical Ohms Short Circuit Current

Range	400	4k	40k	400k	4M	40M
Current	200 µA	80 µA	12 µA	1.4 µA	.2 µA	.2 µA

1. Accuracy is given as ±([% of reading] + [number of least significant digits]) at 18°C to 28°C with relative humidity up to 90%, for a period of one year after calibration. AC conversions are ac-coupled, average responding, and calibrated to the rms value of a sine wave input.

* Below a reading of 200 counts, add 10 digits.

** Frequency range: 1 kHz to 2.5 kHz.

*** When using the REL Δ function to compensate for offsets.

Table 1-1. Specifications, Models 83 and 85 (cont)

Function	Range	Resolution	Accuracy[2]
Capacitance	5.00 nF	0.01 nF	±(1% + 3)
	0.0500 µF	0.0001 µF	±(1% + 3)
	0.500 µF	0.001 µF	±(1% + 3)
	5.00 µF	0.01 µF	±(1.9% + 3)
Diode Test	3.000V	0.001V	±(2% + 1)

Function	Range	Resolution	Accuracy		Burden Voltage Typical
			Fluke 83	Fluke 85	
mA	40.00 mA	0.01 mA	±(1.2%+2)*	±(0.6%+2)*	1.8 mV/mA
A~	400.0 mA	0.1 mA	±(1.2%+2)*	±(0.6%+2)*	1.8 mV/mA
(45 Hz to 2 kHz)	4000 mA	1 mA	±(1.2%+2)*	±(0.6%+2)*	0.03 V/A
	10.00A[3]	0.01A	±(1.2%+2)*	±(0.6%+2)*	0.03 V/A
mA	40.00 mA	0.01 mA	±(0.4%+2)	±(0.2%+2)	1.8 mV/mA
A⎓	400.0 mA	0.1 mA	±(0.4%+2)	±(0.2%+2)	1.8 mV/mA
	4000 mA	1 mA	±(0.4%+2)	±(0.2%+2)	0.03 V/A
	10.00A[3]	0.01A	±(0.4%+2)	±(0.2%+2)	0.03 V/A
~ µA	400.0 µA	0.1 µA	±(1.2%+2)*	±(0.6%+2)*	100 µV/µA
(45 Hz to 2 kHz)	400.0 µA	1 µA	±(1.2%+2)*	±(0.6%+2)*	100 µV/µA
⎓ µA	400.0 µA	0.1 µA	±(0.4%+3)	±(0.2%+3)	100 µV/µA
	4000 µA	1 µA	±(0.4%+2)	±(0.2%+2)	100 µV/µA

Function	Range	Resolution	Accuracy
Frequency	199.99	0.01 Hz	±(0.005%+1)
(0.5 Hz to 200 kHz,	1999.9	0.1 Hz	±(0.005%+1)
pulse width >2 µs	19.999 kHz	0.001 kHz	±(0.005%+1)
	199.99 kHz	0.01 kHz	±(0.005%+1)
	>200 kHz	0.1 kHz	Unspecified

2 With film capacitor or better using Relative mode to zero residual.

3 10A continuous, 20A for 30 seconds maximum.

Table 1-1. Specifications, Models 83 and 85 (cont)

Frequency Counter Sensitivity and Trigger Level			
Input Range	**Minimum Sensitivity (RMS Sinewave)**		
(Maximum input for specified accuracy = 10 X Range or 1000V)	**5 Hz - 20 kHz**	**0.5 Hz - 200 kHz**	**Approximate Trigger Level (DC Voltage Function)**
400 mV dc	70 mV (to 400 Hz)	70 mV (to 400 Hz)	40 mV
400 mV dc	150 mV	150 mV	
4V	0.3V	0.7V	1.7V
40V	3V	7V (≤140 kHz)	4V
400V	30V	70V (≤14.0 kHz)	40V
1000V	300V	700V (≤1.4 kHz)	400V

Duty Cycle 0.1 to 99.9% (0.5 Hz to 200 kHz, pulse width > 2 µs)

Accuracy: Within ±(0.05% per kHz +0.1%) of full scale for a 5V logic family input on the 4V dc range

Within ±((0.06 x Voltage Range/Input Voltage) x 100%) of full scale for sine wave inputs on ac voltage ranges.

Function	Overload Protection[5]	Input Impedance (nominal)	Common Mode Rejection Ratio (1 kΩ unbalance)	Normal Mode Rejection Ratio
$\tilde{\bar{V}}$	1000V rms	10 MΩ < 100 pF	>120 dB at dc, 50 Hz or 60 Hz	>60 dB at 50 Hz or 60 Hz
$\overline{\overline{V}}$ mV	1000V rms	10 MΩ < 100 pF	>120 dB at dc, 50 Hz or 60 Hz	>60 dB at 50 Hz or 60 Hz
$\tilde{V}$	1000V rms	10 MΩ < 100 pF (ac-coupled)	>60 dB, dc to 60 Hz	

Ω		Open Circuit Test Voltage	Full Scale Voltage		Short Circuit Current
			To 4.0 MΩ	40 MΩ or nS	
	1000V rms	<1.3V dc	<450 mV dc	<1.3V dc	<200 µA
Diode Test	1000V rms	<3.9V dc	3.000V dc		0.6 mA typical

5 10^6V Hz max

Table 1-1. Specifications, Models 83 and 85 (cont)

	Nominal Response	Accuracy (5% to 100% of range)
MIN MAX Recording	100 ms to 80%	Specified accuracy ±12 digits for changes >200 ms in duration (±40 digits in AC with beeper on)
	1 s	Same as specified accuracy for changes >2 seconds in duration (±40 digits in AC with beeper on)

Fuse Protection	
mA or µA	44/100A, 1000V FAST Fuse (Min. Interrupt Rating 17,000A)
A	11A, 1000V FAST Fuse (Min. Interrupt Rating 10,000A)

Maximum Voltage Between any Terminal and Earth Ground
1000 Volts - CAT III

Display	Digital: 4000 counts, updates 4/sec Analog: 43 segments, updates 40/sec Frequency: 19,999 counts, updates 3/sec @ > 10 Hz
Operating Temperature	-20°C to 55°C
Storage Temperature	-40°C to 60°C
Temperature Coefficient	0.05 x (specified accuracy)/ °C (<18°C or >28°C)
Electromagnetic Compatibility	In an RF field of 1 V/m on all ranges and functions except capacitance: Total Accuracy = Specified Accuracy +0.3% of range. Capacitance not specified. Performance above 1 V/m is not specified.
Relative Humidity	0% to 90% (0°C to 35°C) 0% to 70% (35°C to 55°C)
Battery Type	9V, NEDA 1604 or 6F22 or 006P
Battery Life	500 hrs typical with alkaline
Shock, Vibration	Per MIL-T-28800 for a Class 2 Instrument
Size (HxWxL)	1.25 in x 3.41 in x 7.35 in (3.1 cm x 8.6 cm x 18.6 cm)
With Holster and Flex-Stand:	2.06 in x 3.86 in x 7.93 in (5.2 cm x 9.8 cm x 20.1 cm
Weight	12.5 oz (355g)
With Holster and Flex-Stand:	22.0 oz (624g)
Safety	Designed to comply with IEC 1010-1 as a 1000V, CAT III instrument. UL listed to UL3111 TUV licensed to EN 61010-1, CSA C22.216 1010.1

Table 1-2. Specifications, Model 87

Function	Range	Resolution	Accuracy[1]			
			50 Hz - 60 Hz	45 Hz - 1 kHz	1 kHz - 5 kHz	5 kHz - 20 kHz[2]
Ṽ	400 mV	0.1 mV	±(0.7% + 4)	±(1.0% + 4)	±(2.0% + 4)	±(2.0% + 20)
	4.000V	0.001V	±(0.7% + 2)	±(1.0% + 4)	±(2.0% + 4)	±(2.0% + 20)
	40.00V	0.01V	±(0.7% + 2)	±(1.0% + 4)	±(2.0% + 4)	±(2.0% + 20)
	400.0V	0.1V	±(0.7% + 2)	±(1.0% + 4)	±(2.0% + 4)*	unspecified
	1000V	1V	±(0.7% + 2)	±(1.0% + 4)[2]	unspecified	unspecified
V̿	4.000V	0.001V	±(0.1% + 1)			
	40.00V	0.01V	±(0.1% + 1)			
	400.0V	0.1V	±(0.1% + 1)			
	1000V	1V	±(0.1% + 1)			
~~mA⎓~~	400.0 mV	0.1 mV	±(0.1% + 1)			
Ω	400.0Ω	0.1Ω	±(0.2% + 2)**			
	4.000 kΩ	0.001 kΩ	±(0.2% + 1)			
	40.00 kΩ	0.01 kΩ	±(0.2% + 1)			
	400.0 kΩ	0.1 kΩ	±(0.6% + 1)			
	4.000 MΩ	0.001 MΩ	±(0.6% + 1)			
	40.00 MΩ	0.01 MΩ	±(1% + 3)			
(nS)	40.00 nS	0.01 nS	±(1% + 10)			

Function	Range	Resolution	Accuracy[2]
Capacitance	5.00 nF	0.01 nF	±(1% + 3)
	0.0500 µF	0.0001 µF	±(1% + 3)
	0.500 µF	0.001 µF	±(1% + 3)
	5.00 µF	0.01 µF	±(1.9% + 3)
Diode Test	3.000V	0.001V	±(2% + 1)

Function	Range	Resolution	Accuracy	Burden Voltage Typical
mA	40.00 mA	0.01 mA	±(1.0%+2)	1.8 mV/mA
A~	400.0 mA	0.1 mA	±(1.0%+2)	1.8 mV/mA
(45 Hz to 2 kHz)	4000 mA	1 mA	±(1.0%+2)	0.03 V/A
	10.00A[4]	0.01A	±(1.0%+2)	0.03 V/A
mA	40.00 mA	0.01 mA	±(0.2%+2)	1.8 mV/mA
A⎓	400.0 mA	0.1 mA	±(0.2%+2)	1.8 mV/mA
	4000 mA	1 mA	±(0.2%+2)	0.03 V/A
	10.00A[4]	0.01A	±(0.2%+2)	0.03 V/A

Typical Ohms Short Circuit Current

Range	400	4k	40k	400k	4M	40M
Current	200 µA	80 µA	12 µA	1.4 µA	.2 µA	.2 µA

1. Accuracy is given as ±([% of reading] + [number of least significant digits]) at 18°C to 28°C, with relative humidity up to 90%, for a period of one year after calibration. In the 4½-digit mode, multiply the number of least significant digits (counts) by 10. AC conversions are ac-coupled, true rms responding, calibrated to the rms value of a sine wave input, and valid from 5% to 100% of range. AC crest factor can be up to 3 at full scale, 6 at half scale. For non-sinusoidal wave forms add -(2% Rdg x 2% Fs) typical, for a crest factor up to 3.
2. Below 10% of range, add 6 digits.
3. With film capacitor or better using Relative mode to zero residual.
4. 10A continuous, 20A for 30 seconds maximum.

* Frequency range: 1 kHz to 2.5 kHz

** When using the REL Δ function to compensate for offsets.

Table 1-2. Specifications, Model 87 (cont)

Function	Range	Resolution	Accuracy	Burden Voltage Typical
µA (45 Hz to 2 kHz)	400.0 µA 400.0 µA	0.1 µA 1 µA	±(1.0%+2) ±(1.0%+2)	100 µV/µA 100 µV/µA
⎓ µA	400.0 µA 4000 µA	0.1 µA 1 µA	±(0.2%+3) ±(0.2%+2)	100 µV/µA 100 µV/µA

Function	Range	Resolution	Accuracy
Frequency (0.5 Hz to 200 kHz, pulse width >2 µs	199.99 1999.9 19.999 kHz 199.99 kHz >200 kHz	0.01 Hz 0.1 Hz 0.001 kHz 0.01 kHz 0.1 kHz	±(0.005%+1) ±(0.005%+1) ±(0.005%+1) ±(0.005%+1) Unspecified

Frequency Counter Sensitivity and Trigger Level			
Input Range	**Minimum Sensitivity (RMS Sinewave)**		
(Maximum input for specified accuracy = 10 X Range or 1000V)	**5 Hz - 20 kHz**	**0.5 Hz - 200 kHz**	**Approximate Trigger Level (DC Voltage Function)**
400 mV dc	70 mV (to 400 Hz)	70 mV (to 400 Hz)	40 mV
400 mV dc	150 mV	150 mV	—
4V	0.3V	0.7V	1.7V
40V	3V	7V (≤ 140 kHz)	4V
400V	30V	70V (≤14.0 kHz)	40V
1000V	300V	700V (≤1.4 kHz)	400V

Duty Cycle 0.1 to 99.9% (0.5 Hz to 200 kHz, pulse width > 2 µs)

Accuracy: Within ±(0.05% per kHz +0.1%) of full scale for a 5V logic family input on the 4V dc range

Within ±((0.06 x Voltage Range/Input Voltage) x 100%) of full scale for sine wave inputs on ac voltage ranges.

Table 1-2. Specifications, Model 87 (cont)

Function	Overload Protection[6]	Input Impedance (nominal)	Common Mode Rejection Ratio (1 kΩ unbalance)	Normal Mode Rejection Ratio
$\tilde{V}$	1000V rms	10 MΩ < 100 pF	>120 dB at dc, 50 Hz or 60 Hz	>60 dB at 50 Hz or 60 Hz
⎓ mV	1000V rms	10 MΩ < 100 pF	>120 dB at dc, 50 Hz or 60 Hz	>60 dB at 50 Hz or 60 Hz
$\tilde{V}$	1000V rms	10 MΩ < 100 pF (ac-coupled)	>60 dB, dc to 60 Hz	

Ω		Open Circuit Test Voltage	Full Scale Voltage		Short Circuit Current
			To 4.0 MΩ	40 MΩ or nS	
	1000V rms	<1.3V dc	<450 mV dc	<1.3V dc	< 200 µA
Diode Test	1000V rms	<3.9V dc	3.000V dc		0.6 mA typical

	Nominal Response	Accuracy (5% to 100% of range)
MIN MAX Recording	100 ms to 80% (DC Functions)	Specified accuracy ±12 digits for changes >200 ms in duration
	120 ms to 80% (AC Functions)	Specified accuracy ±40 digits for changes >350 ms and inputs >25% of range.
	1 s	Same as specified accuracy for changes >2 seconds in duration
	1 ms	Specified accuracy ±40 digits for changes >1 ms in duration. (±100 digits typical for mV, 400 µA dc, 40 mA dc, 4000 mA dc).

Fuse Protection	
mA or µA	44/100A, 1000V FAST Fuse (Min. Interrupt Rating 17,000A)
A	11A, 1000V FAST Fuse (Min. Interrupt Rating 10,000A)

Maximum Voltage Between any Terminal and Earth Ground
1000 Volts - CAT III

6 10^6V Hz max

Table 1-2. Specifications, Model 87 (cont)

Display	Digital: 4000 counts, updates 4/sec 19,999 counts (4½-digit mode), updates 1/sec Analog: 4 x 32 segments (equivalent to 128), updates 40/sec Frequency: 19,999 counts, updates 3/sec @ > 10 Hz
Operating Temperature	-20°C to 55°C
Storage Temperature	-40°C to 60°C
Temperature Coefficient	0.05 x (specified accuracy)/ °C (<18°C or >28°C)
Electromagnetic Compatibility	In an RF field of 1 V/m on all ranges and functions except capacitance: Total Accuracy = Specified Accuracy +2.5% of range. Capacitance not specified. Performance above 1 V/m is not specified.
Relative Humidity	0% to 90% (0°C to 35°C) 0% to 70% (35°C to 55°C)
Battery Type	9V, NEDA 1604 or 6F22 or 006P
Battery Life	400 hrs typical with alkaline
Shock, Vibration	Per MIL-T-28800 for a Class 2 Instrument
Size (HxWxL)	1.25 in x 3.41 in x 7.35 in (3.1 cm x 8.6 cm x 18.6 cm)
With Holster and Flex-Stand:	2.06 in x 3.86 in x 7.93 in (5.2 cm x 9.8 cm x 20.1 cm)
Weight	12.5 oz (355g)
With Holster and Flex-Stand:	22.0 oz (624g)
Safety	Designed to comply with IEC 1010-1 as a 1000V, CAT III instrument. UL listed to UL3111 TUV licensed to EN 61010-1, CSA C22.216 1010.1

Chapter 2
Theory of Operation

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2-1. Introduction

This section describes the theory of operation for the Fluke 83, 85, and 87 Multimeters. Unless otherwise specified, the descriptions apply to all three instruments.

Functional block descriptions present an initial overview of circuit operation. Detailed circuit descriptions then cover the major circuit functions in more detail. For reference, detailed schematic diagrams are included in Section 5.

2-2. Functional Block Description

Refer to Figure 2-1 for a block diagram of the Fluke 83, 85, and 87 Multimeters. The instrument is partitioned into analog and digital sections. The integrated multimeter chip (U4) performs both analog and digital functions. Also, note that the Fluke 87 incorporates additional analog circuits.

The analog section of U4 contains the a/d converter, active filter, ac converter (for Models 83 and 85), frequency comparator, analog signal routing, range switching, and power supply functions.

The digital logic portion of U4 provides the state machine for synchronous a/d converter control and the 16-bit counter used for a/d converter counts and frequency measurements. Also, the digital logic section contains bus and interrupt control circuits (to facilitate the microcomputer interface) and registers for analog switch drive.

The microcomputer section of U4 executes software functions, formats data for the display, drives the display, and controls most analog and digital logic functions. The mode switch push buttons initiate various operating modes for the microcomputer. Output from the microcomputer can be presented visually on the liquid crystal display (LCD) and audibly on the beeper.

2-3. Detailed Circuit Description

Each of the functional blocks in Figure 2-1 is discussed in greater detail in the following paragraphs. The schematic diagrams located at the end of this manual can be consulted for details not portrayed in the figures in this section.

2-4. Input Overload Protection

Overload protection for the VΩ→|← input is provided by a network of two metal-oxide varistors (RV1 and RV2), three current-limiting resistors (R1, R2, and RT1), and spark gap E1. Resistor R1 limits inrush current and thermistor RT1 rises to a high impedance during a sustained voltage overload in the millivolts dc, ohms, or diode test mode. A voltage clamp network is formed by transistors Q1, Q2, and Q6, diodes CR7 and CR8, and resistor R58. During ohms and diode test overloads, this clamp circuit limits the overload current to U4 at 10 mA. Power supply regulation and system operation is maintained during any of these overloads.

Overload protection for the mA μA input is provided by F1, rated at 44/100A, 1000V. The A input is protected by F2, rated at 11A, 1000V. In addition, the microamp shunt resistors (R4 and R43) are protected from overload currents below the F1 fusing level by the U1 and CR1 diode network.

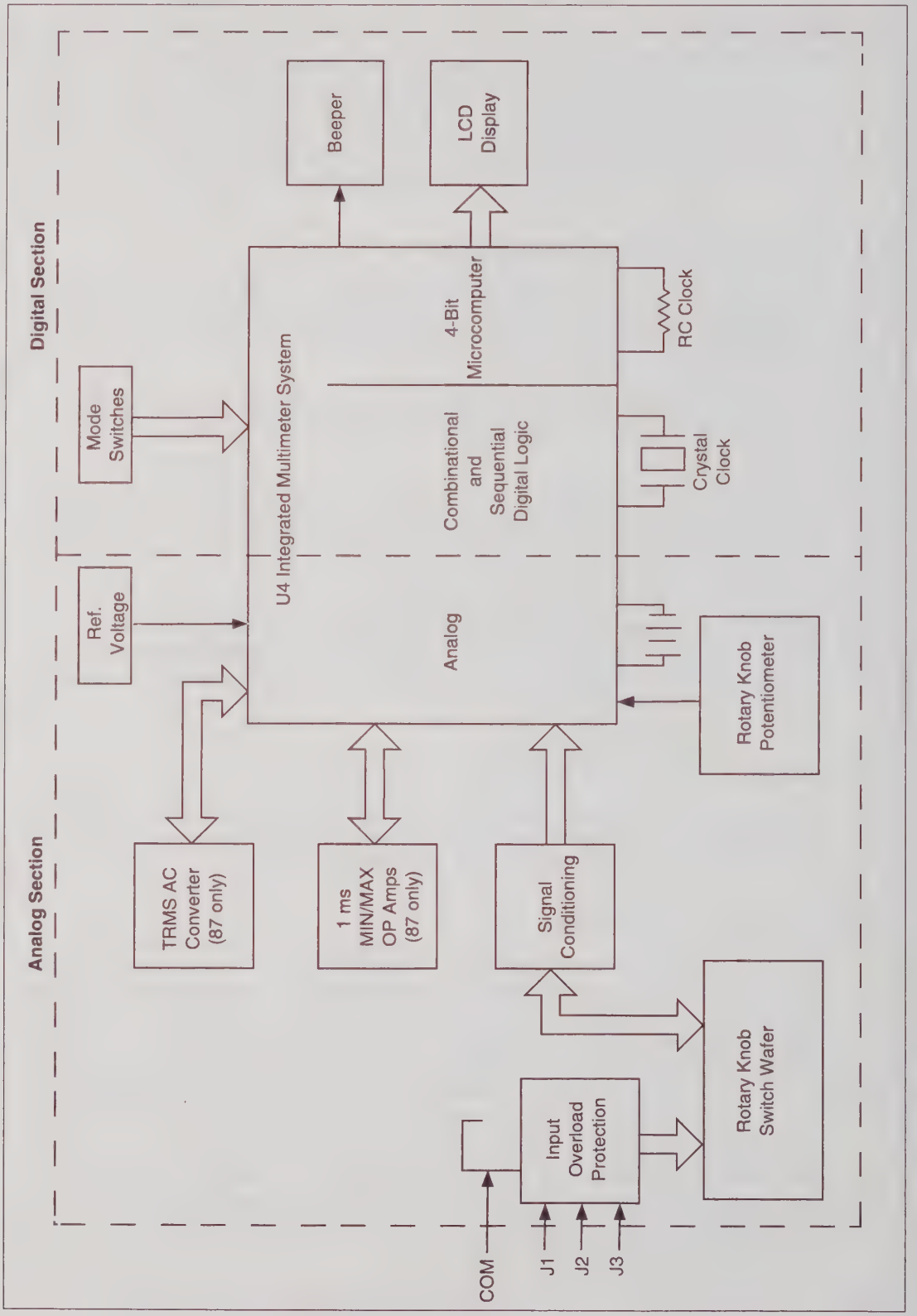


Figure 2-1. Overall Functional Block Diagram

The 83/85/87 Input-Alert feature provides a beeper warning signal when an input jack is connected to a current input and a non-current function is selected with the rotary switch. The meter detects the presence of an input connection by using split jacks at the mA μA and A inputs. One side of the jack is connected to an overload protection resistor (R7 for mA μA, R10 for A). In turn, R7 and R10 are connected to U4 sense lines AP4 and AP5 (pins 89 and 88). Resistors R8 and R48 provide Vdd pull up for AP4, and R11 is the pull up resistor for AP5. When a connection is made at mA μA or A, the sense side of the jack is pulled to COM. This condition is detected and compared with the selected function by U4. If a conflict exists, the beeper warning is activated.

2-5. Rotary Knob Switch and Potentiometer

Input signals are routed from the overload protection circuits to a double-sided switch wafer, which provides the necessary switching to implement the various signal conditioning. The function-encoding potentiometer is attached to the associated rotary switch shaft. After turn on, or a knob position change, U4 performs a voltage ratio measurement on this potentiometer to determine the new function.

2-6. Input Signal Conditioning Circuits

Each input signal is routed through signal conditioning circuitry before reaching U4. Input signals received through the VΩ→⊣⊢ input are routed through Z1, a precision resistor network. This input divider network provides precise input scaling for the various voltage ranges and precision reference resistors for the ohms and capacitance functions. The capacitors in parallel with the various resistors in Z1 are used for high frequency compensation.

The input divider is used in two modes. In volts functions, a series mode is used to provide four divider ratios. In the ohms function, a parallel mode provides five reference resistors. During the following discussion, refer to the schematic and signal flow diagrams in Section 5.

2-7. Volts

In Volts functions, signal flow for input divider Z1 begins with the unknown voltage at the VΩ→⊣⊢ input, which is connected to the high end of the 9.996 MΩ resistor (pin 1 of Z1) through R1 and RT1. In AC volts, C1 is also connected in series. In DC volts, C1 is shorted by S1 (contacts 3 and 4). Internal switches connect the 9.996 MΩ and 1.1111 MΩ resistors (pin 2 to pin 3 of Z1). The low end of the 1.1111 MΩ resistor (pin 7 of Z1) is connected to COM through S1 contacts 1 and 2, producing the divide-by-10 ratio used in the 400 mV ac, 4V ac, and 4V dc ranges.

For the 40V range, internal switches connect a 101.01 kΩ resistor to provide a divide-by-100 ratio. In the 400V range, 10.01 kΩ is used for a divide-by-1000 ratio. And a 1.0001 kΩ resistor is used in the 1000V range to provide a divide-by-10000 ratio.

The internal switch resistance connecting the 1.1111 MΩ and 9.996 MΩ with the other resistors is approximately 4 kΩ. Since the A/D senses the voltage at APV1 of U4 (pin 3 of Z1), the internal switch resistance adds to the 9.996 MΩ resistor, making for a circuit total of 10 MΩ.

2-8. Ohms

In the 400 ohm range the internal switches connect the 9.996 MΩ resistor (pin 2 of Z1) to the 1.0001 kΩ resistor (pin 6 of Z1); contacts 5 and 3 of S1 connect the remaining ends to of these resistors, making a reference resistor of 1 kΩ. Again, the 4 kΩ internal switch resistance adds to the 9.996 MΩ.

The source voltage is connected internally at both APV0 and APV4 of U4. The current is routed through the 1.0001 kΩ and 9.996 MΩ resistors, into S1 at contacts 3 and 5, out of S1 at contact 4, through R1 and RT1, out the VΩ⊣⊢ input, through the unknown resistance, and back to COM. The same current flows through the unknown resistance and the reference resistor. The voltage dropped across the unknown resistance is sensed from the VΩ⊣⊢ input jack through R2 and S1 (contacts 11 and 12) to AP1 of U4.

The A/D senses the voltage drop across the 1k reference resistor through the low (AP2 of U4 through R13) and high (APV0 and APV4) points. These two voltages are used by the A/D Converter to perform a ratiometric measurement.

For the 4 kΩ range, the 10.010 kΩ resistor used in parallel with the 9.996 MΩ resistor forms a 10 kΩ reference resistor. In the 40 kΩ range, 101.01 kΩ and 9.996 MΩ form a 100 kΩ reference resistor. And in the 400 kΩ range, 1.1111 MΩ and 9.996 MΩ provide a 1 MΩ reference resistor. The 4 MΩ and 40 MΩ use only the 9.996 MΩ resistor.

2-9. Analog Section of Integrated Multimeter IC (U4)

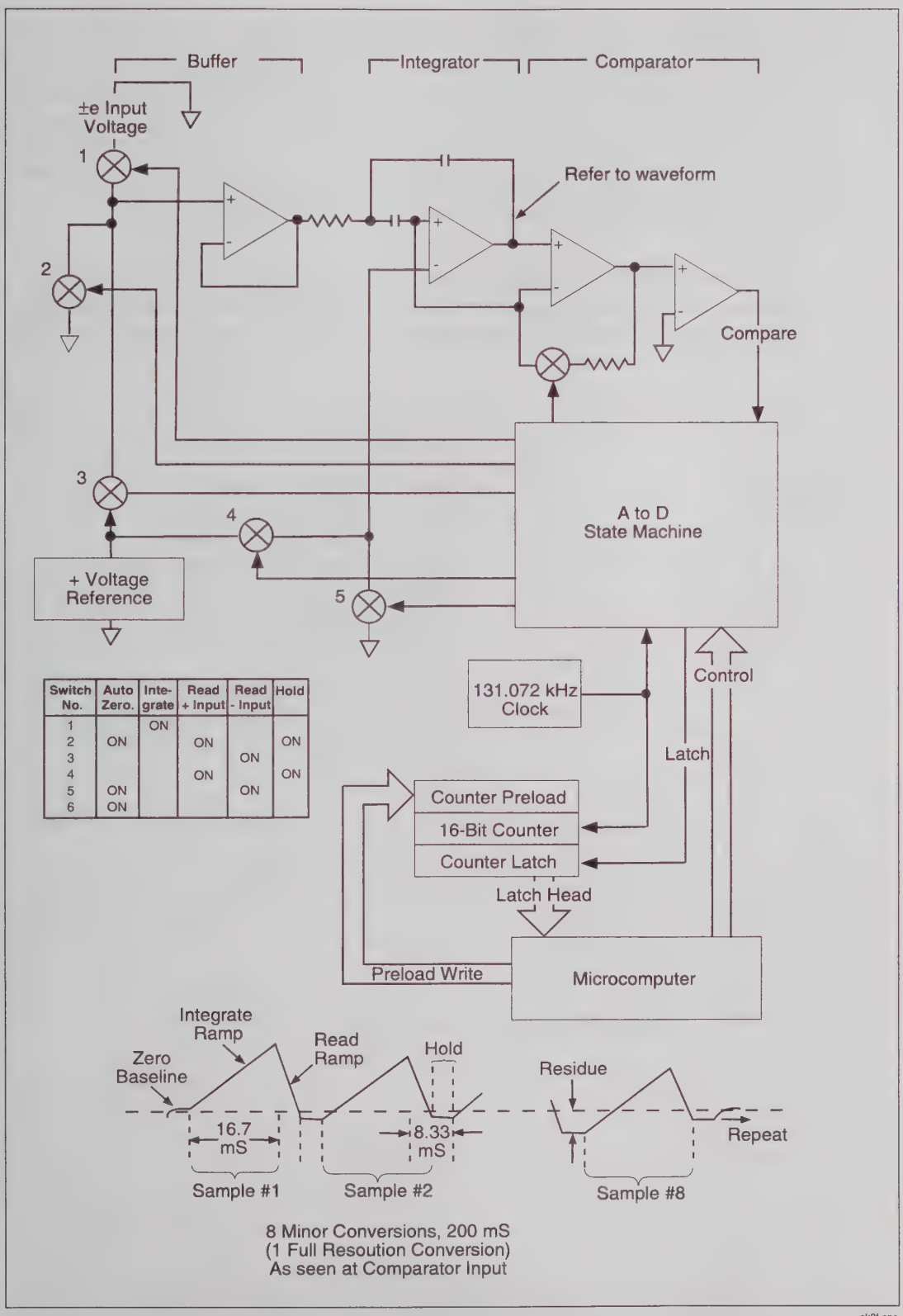
The analog-to-digital converter, autorange switching, frequency comparator, and most of the remaining analog circuitry are contained in the analog section of U4. Peripherals to this U4 analog section include the crystal clock, the system reference voltage, and some filter and amplifier resistors and capacitors. Included in the Fluke 87 only is a peripheral 1 ms MIN/MAX circuit and a true rms (root-mean-square) ac-to-dc converter.

Analog-to-digital conversion is accomplished within U4 using the dual-rate, dual-slope a/d converter circuit shown in Figure 2-2. For most measurements, the basic a/d rate cycle lasts 25 ms, for 40 measurements-per-second. A single conversion at this rate is called a minor cycle sample. Each minor cycle sample is used to provide 40 updates-per-minute for the fast response bar graph display, fast MIN/MAX recording, and fast autoranging.

Eight minor cycle samples are necessary to accumulate data for displaying a full-resolution (4000 count full scale) measurement on the digital display. A 40 ms autozero phase occurs following every eight-sample sequence. Therefore, each digital display update requires 240 ms, approximating 4 updates-per-second.

Basic a/d conversion elements and waveforms are illustrated in Figure 2-2. As this figure shows, a residual charge is retained by the integrator capacitor due to the overshoot past the true-zero base line. In the absence of an autozero phase, the residual charge would normally produce a significant error in the sample taken next. However, a digital algorithm eliminates the error and accounts for the residual as it propagates through all eight samples.

Basic timing for the a/d converter is defined as a series of eight integrate read cycles, followed by a 40 ms autozero phase. However, the 40 MΩ, capacitance, overload recovery, autoranging, Touch-Hold, 100 ms Min/Max, 1 ms Min/Max (Fluke 87 only), and rotary knob potentiometer modes all require variations from the basic timing.



ek2f.eps

Figure 2-2. A/D Conversion

Capacitance measurements to 5.0 µF are made by measuring the charge required to change the voltage across the unknown capacitor from zero to the system reference voltage. This technique is referred to as a ballistic type of measurement, the elements of which are shown in Figure 2-3. The unknown capacitor is fully charged from zero during the a/d converter integrate cycle. The signal integrated by the a/d converter constitutes the voltage drop across one or more precision resistors (Z1). The reference voltage is the de-integration signal for the a/d. Cx is discharged during de-integrate, hold, and autozero. The microcomputer calculates a display value from the latched count, which is proportional to the unknown capacitance. Capacitance mode uses two samples per display update.

A voltage comparator, with microcomputer configurable offsets, is used for both signal detection in frequency and duty cycle modes and threshold detection in continuity mode. In frequency and duty cycle modes, digital pulses from the voltage comparator are routed to the 16-bit counter.

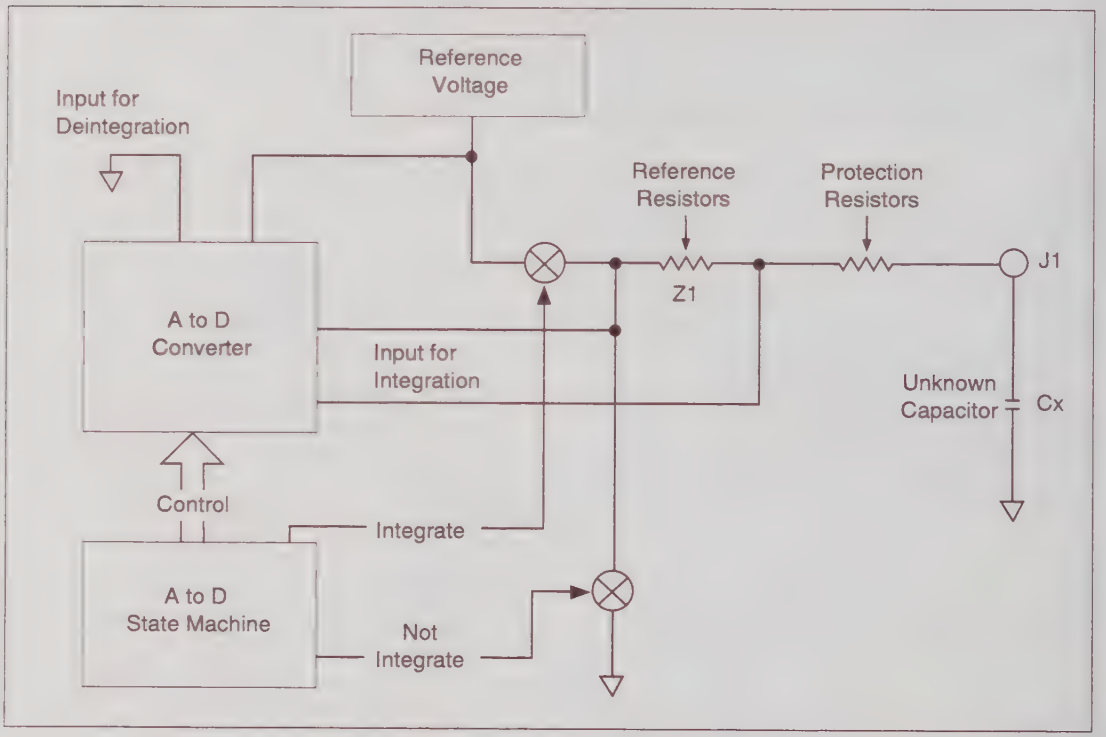


Figure 2-3. Capacitance Measurement Elements

2-10. Digital Section of Integrated Multimeter IC (U4)

Digital circuitry in U4 (excluding the microcomputer) is partitioned into five functional blocks, as shown in Figure 2-4.

- A bus control cell performs address decoding and manages selective power down, split jack sense, and low battery signals.
- The interrupt control cell manages and multiplexes four interrupts to the microcomputer. These interrupts are for 16-bit and 8-bit counter carries and voltage comparator transitions.
- A 48-bit write-only register latches microcomputer data for analog switch drive.
- A 16-bit counter (with parallel preload and latch registers) is used as a read counter for a/d conversions and as a pulse counter for frequency and duty-cycle measurements.
- The a/d converter is controlled by a 4-bit state machine with output decoding ROM.

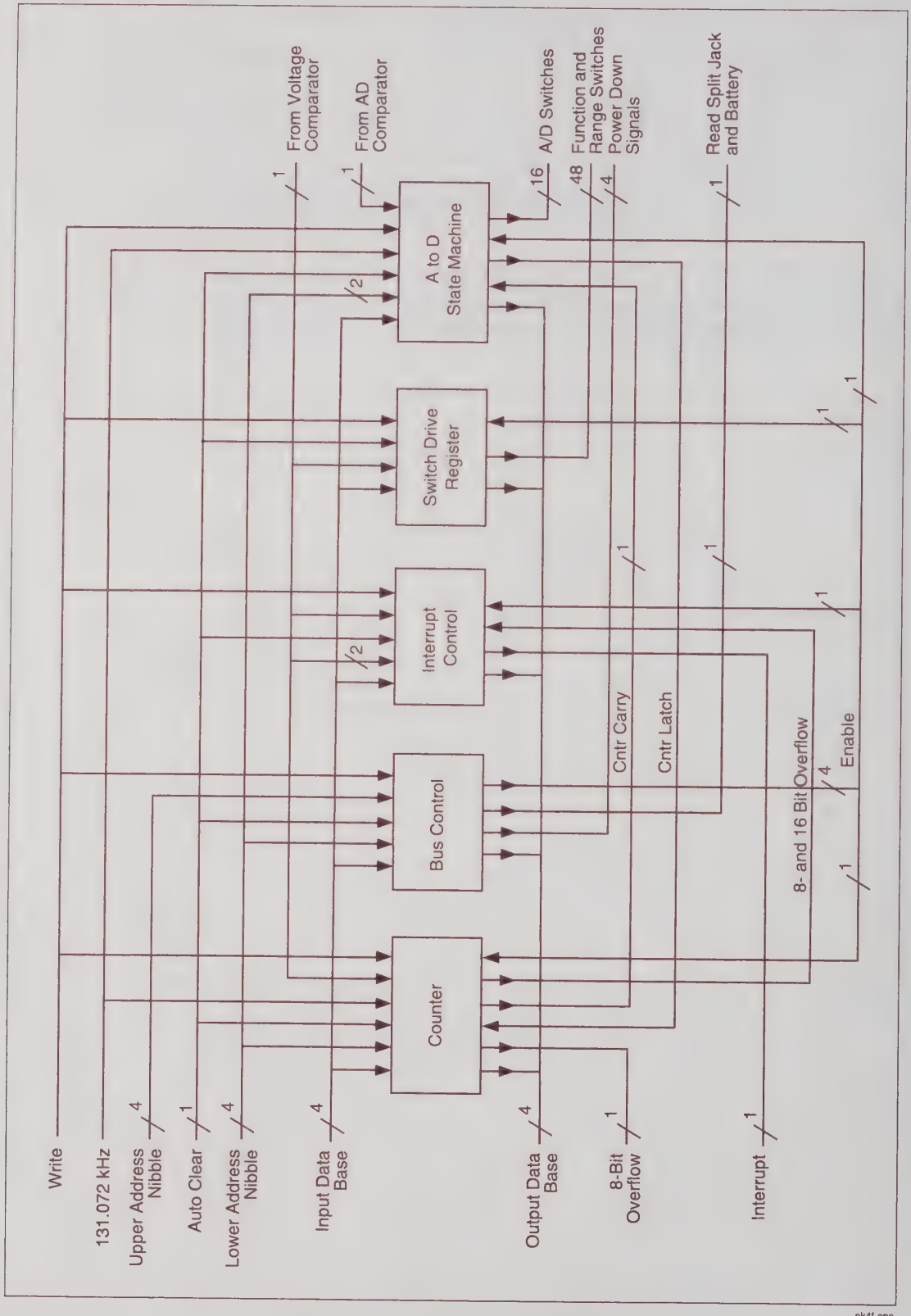


Figure 2-4. Digital Circuitry Within U4

Figure 2-5 is a block diagram of frequency counter components. For frequency and duty cycle measurements, the 16-bit counter in the digital section of U4 is partitioned into two 8-bit counters. Each of these counters is then extended to 20 bits using microcomputer software and hardware. The gating logic controls the start and stop of each reading. In frequency mode, signal A is the unknown frequency, and signal B is the crystal clock signal. After enough counts have been accumulated in each 20-bit register, the microcomputer calculates the unknown frequency from the ratio of the counter values.

In making a duty cycle measurement, signal A (Figure 2-5) is again the unknown signal, but signal B is the logical AND of the unknown and reference signals. As with frequency measurement, the microcomputer controls the start and stop of a measurement cycle via the gating logic. The ratio of the counter values yields the duty cycle value.

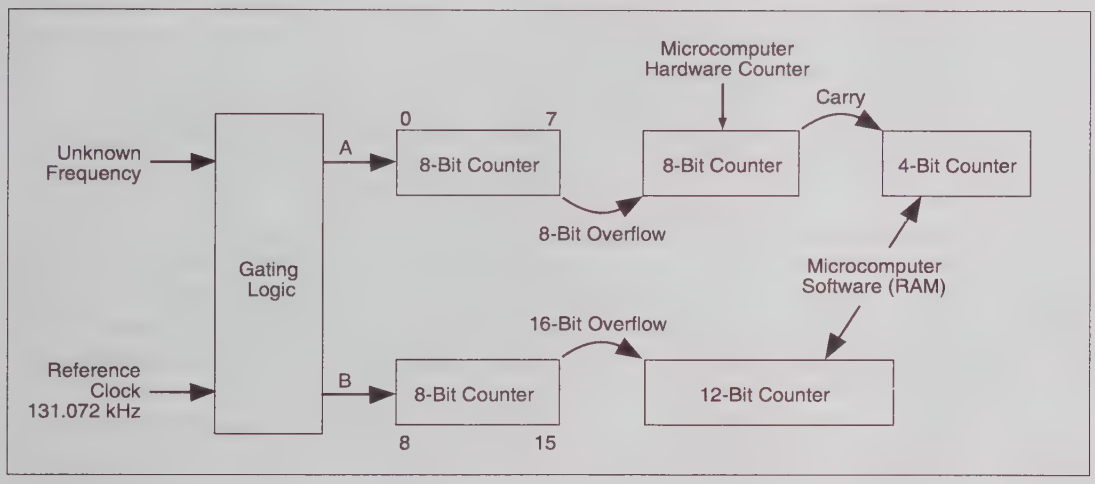


Figure 2-5. Frequency Counter Elements

2-11. Microcomputer Control

A 4-bit microcomputer, integrated within U4, controls the various instrument functions and drives the display. A/D converter and counter measurements are controlled via the microcomputer interface lines shown in Figure 2-4. Min/Max, Touch-Hold, and REL (relative) modes involve additional data processing by the microcomputer to generate the display value.

The microcomputer/digital logic interface consists of both RAM that has been mapped into the digital logic and an interrupt line back to the microcomputer. The four interrupts are maskable, readable, and resettable. Note that the microcomputer runs on its own RC clock at a frequency of 525 to 800 kHz and is asynchronous from the crystal clock.

The microcomputer exercises direct control over the ranging and signal routing analog switches. A specific word is written to the switch drive register for each function/range selection. In autoranging (default) mode, the microcomputer determines the correct range based on the input. In addition, for autoranging during voltage, ohms, or current measurements, the active filter fast mode is enabled for quick response. In frequency or duty cycle mode, pushing the range button causes a range change in the primary function (volts, amps, etc.) that may change the sensitivity or offset.

The microcomputer sets the required a/d converter mode, which determines the on-chip analog signal ports to be used for the integrate and de-integrate signals. The microcomputer also selects one of the three available gain resistors in Z1 for integrate

and de-integrate. All voltage and current conversions use either a 400 mV or a 40 mV full scale mode. Other modes are used for ohms, hiohms, 40 MΩ, nS, and capacitance. Since the a/d state machine timing is under direct software control, a mode invoked in another function or range can use different timing.

Frequency measurements are also controlled by the microcomputer section of U4. The microcomputer initializes the counters, monitors the count accumulation, arms and disarms the logic signal gating, and calculates the display value from the counter values.

Min/Max Record (1s and 100 ms), Touch-Hold, and Relative are secondary software functions. This means that the microcomputer performs either a different control algorithm or a different math routine on the data, as explained below.

- In Min/Max Record mode, the maximum and minimum readings after initialization are stored in memory, and a true running average is calculated after each reading. The running average is updated for a maximum of 36 hours. The MIN MAX button allows the user to scroll through the min, max, average, and present readings. In 100 ms Min/Max a single sample is used to calculate the display value, while in 1s Min/Max a full resolution conversion is used. Note that 1 ms Peak Min/Max (Fluke 87 only) requires additional analog peak hold amplifiers external to U4.
- When Touch-Hold is selected, the microcomputer does not allow a full resolution conversion to be completed unless the input signal is stable. When a stable reading occurs, the conversion is completed, and the microcomputer generates and freezes the corresponding display. The microcomputer now waits for a change in the signal to exceed a certain threshold, then begins watching for a stable reading again. Note that a reading is forced when Touch Hold is first selected. Also, open test lead signals do not update the display.
- With the REL button (relative) selected, the microcomputer stores the present reading as an offset. This value is subtracted from all subsequent readings (provided that they are on scale) to give the display value.

2-12. Peripherals to U4

In addition to input overload protection and input signal conditioning circuits, other devices peripheral to U4 are needed to support 80 series features. The ac converter, active filter, and a/d converter circuits require off-chip resistors and capacitors. Digital drive and level-shifting circuits are needed for the beeper drive, quick turn off, true RMS converter power down (Fluke 87 only), and LCD back light (also Fluke 87 only) features. A voltage reference is generated separate from U4, and some discrete resistors and transistors support the power supply. The Fluke 87 also uses two analog peak hold circuits (1 ms Min/Max).

2-13. AC Buffer

The ac buffer circuit differs between the Fluke 83/85 and the Fluke 87. On the Fluke 83/85, R14, R15, C5, and C27 are part of the ac buffer circuit that drives the ac converter and guard. The Fluke 83/85 ac buffer can be configured for an ac gain of 1 or 10. For the Fluke 87, R14, R15, R46, C5, and C27 support the ac buffer. This buffer can be configured for an ac gain of ½, 1, 5, or 10. The gains of ½ and 5 are needed for the true rms converter, which uses a 200 mV full scale input. In the Fluke 87, the ac buffer drives the rms ac converter, guard, and peak hold amplifiers.

2-14. AC Converter

The Fluke 83/85 average ac converter uses off-chip components R30, R31, R34, R40, C24, C28, and C29. This ac converter is a full-wave rectifying converter with a differential output and gain selected to give a dc output equal to the rms value for a sine wave input. Filtering is provided by C28 and C29.

2-15. RMS Converter

The Fluke 87 uses an integrated rms-to-dc converter (U2). Devices R34, R45, C6, and C7 support U2, while Q4, R32, and R39 drive the power on/off pin.

2-16. Active Filter

On all models, the active filter uses off-chip passive components R17, R18, C8, and C9. The active filter is a second order low pass filter with two poles at 5.9 Hz in normal mode. It filters input signal noise and ac ripple from the ac converter, yielding stable a/d converter readings. The microcomputer can disable the filter completely or enable the filter fast response mode.

2-17. A/D Converter

Pins 8, 9, and 10 on precision resistor network Z1 connect to the three a/d converter gain resistors. Pin 8 connects to 190 kΩ for a gain of 0.87. Pin 9 connects to 160 kΩ for a gain of 1, and pin 10 connects to 16 kΩ for a gain of 10. Pin 11 is the common connection. The autozero capacitor (C10) stores op amp and comparator offsets. The integration capacitor is C11.

2-18. Beeper

Devices Q9, Q11, R56, R57 and CMOS hex inverter U6 make up the double-ended beeper drive circuit. Transistor Q12 is connected to provide quick microcomputer power down when the instrument is turned off.

2-19. System Reference

The system reference voltage (1.235V) is generated by VR1 and R44. The 1.000V reference voltage for the a/d converter is supplied through U4-1 (REFI). This voltage is adjusted by R21, the dc calibration potentiometer. In addition to generating the a/d reference, the VR1 voltage is used for power supply reference, voltage comparator selectable offset generation, and the ohms source level.

2-20. Power Supply

The power supply consists of two regulators, one shunt and one series, which set Vdd at +3.0V and Vss at -3.2V for all battery voltages down to 6.7V. The shunt (common) regulator sets |Vdgnd - Vss| (Vdgnd = COM = 0V) and consists of an uncompensated op amp and large current shunt devices integrated on U4. Resistors R37 and R38 provide voltage division. The series (Vdd) regulator, which sets |Vdd - Vdgnd|, is made up of another on-chip, uncompensated op amp, along with devices Q3, R24, and R25. Q3 is the series regulator element, and R24 and R25 are for voltage sensing. Capacitors C14 and C21 provide circuit compensation and power supply decoupling for the shunt and series regulators, respectively. Voltage level information is presented in Table 2-1.

Table 2-1. Typical Voltage Levels and Tolerance

VDD	3.0 ±0.3
VSS	-3.2 ±0.3
VBT+	3.5 ±0.3
VBT-	5.5 (battery at full 9V charge) 5.0 (battery at low charge of 6.5V)
REFH	1.235 ±0.012
PS0	1.235 ±0.15
PS1	0 ±0.15
AP6	-0.5 to -0.15
VOA	2.2 to 1.7 (referenced from VSS)
VOB	1.017 to .90 (referenced from VSS)

2-21. Peak Hold

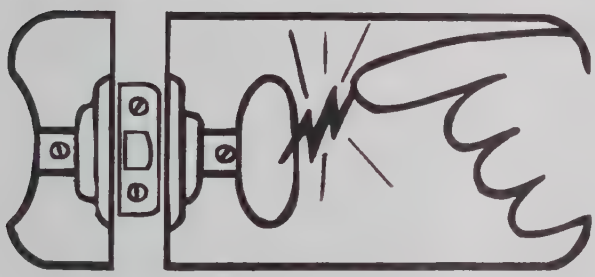
The 1 ms Min/Max mode on the Fluke 87 is implemented using the peak hold circuit consisting of the dual op amp package AR1, diodes CR2 and CR3, C12, C13, R22, and R23. The op amp connected to CR2 charges C12 to the most positive voltage at its input after initialization (which can be positive or negative in amplitude.) CR2 prevents C12 from being discharged after the peak input is no longer present. The op amp connected to CR3 works in a similar fashion, but captures negative peaks. Upon selection of 1 ms Min/Max, U4 initializes the circuit by connecting AP7 (pin 86) to Vss and AP8 (pin 85) to Vdd via on-chip switches. Leakage currents are controlled so that the voltages on C12 and C13 drift towards the AR1 op amp input level. The voltages stored on C12 and C13 are read, in a single sample, to give the display minimum and maximum values.

2-22. Display

The liquid-crystal display (LCD) operates under direct control of the microcomputer. Characters are generated by the computer and displayed on the LCD. Both digital readings and an analog bar-graph (or pointer for Fluke 87) display are presented, in conjunction with annunciators and decimal points. The Fluke 87 features a transflective LCD with a light-emitting diode (LED) back light. Refer to the Fluke 83/85 or 87 Operator's Manual for a more detailed description of the display.

static awareness

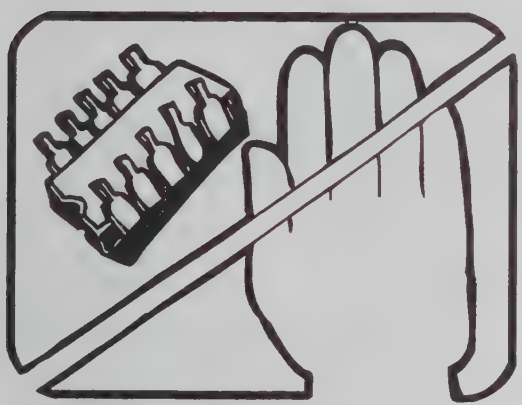
A Message From
Fluke Corporation



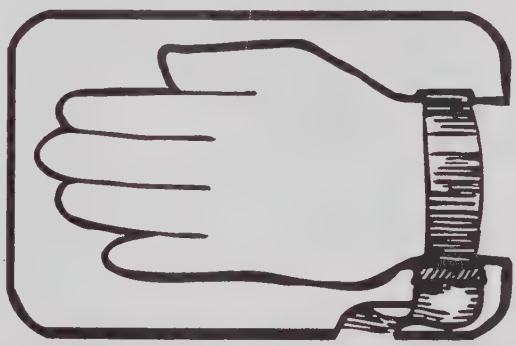
Some semiconductors and custom IC's can be damaged by electrostatic discharge during handling. This notice explains how you can minimize the chances of destroying such devices by:

1. Knowing that there is a problem.
2. Leaning the guidelines for handling them.
3. Using the procedures, packaging, and bench techniques that are recommended.

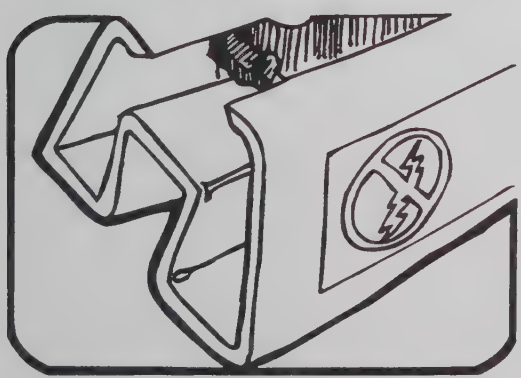
The following practices should be followed to minimize damage to S.S. (static sensitive) devices.



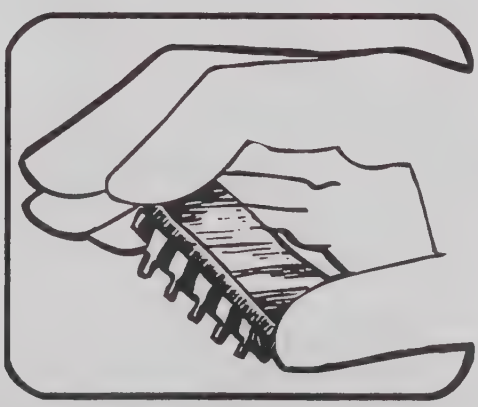
1. MINIMIZE HANDLING



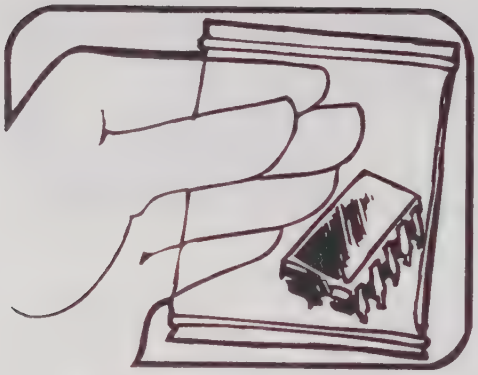
3. DISCHARGE PERSONAL STATIC BEFORE HANDLING DEVICES. USE A HIGH RESISTANCE GROUNDING WRIST STRAP.



2. KEEP PARTS IN ORIGINAL CONTAINERS UNTIL READY FOR USE.

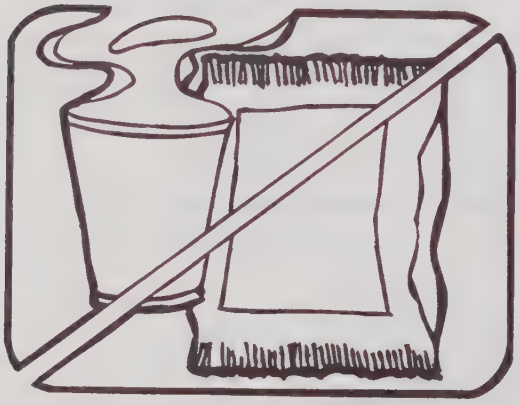


4. HANDLE S.S. DEVICES BY THE BODY.

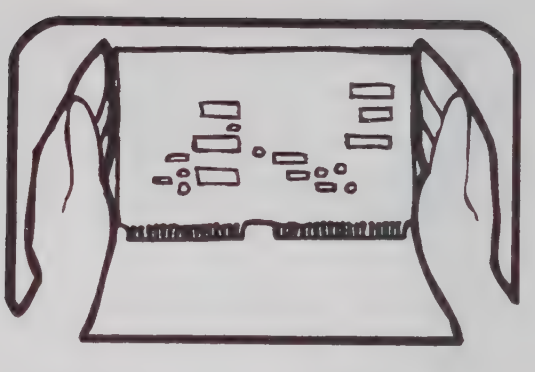


5. USE STATIC SHIELDING CONTAINERS FOR HANDLING AND TRANSPORT.

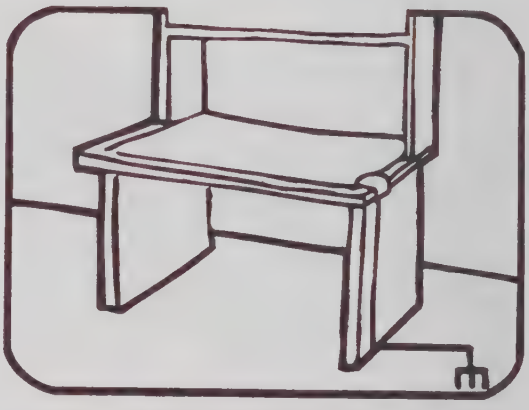
6. DO NOT SLIDE S.S. DEVICES OVER ANY SURFACE.



7. AVOID PLASTIC,VINYL AND STYROFOAM® IN WORK AREA.



8. WHEN REMOVING PLUG-IN ASSEMBLIES HANDLE ONLY BY NON-CONDUCTIVE EDGES AND NEVER TOUCH OPEN EDGE CONNECTOR EXCEPT AT STATIC-FREE WORK STATION. PLACING SHORTING STRIPS ON EDGE CONNECTOR HELPS PROTECT INSTALLED S.S. DEVICES.



9. HANDLE S.S. DEVICES ONLY AT A STATIC-FREE WORK STATION.

10. ONLY ANTI-STATIC TYPE SOLDER-SUCKERS SHOULD BE USED.

11. ONLY GROUNDED-TIP SOLDERING IRONS SHOULD BE USED.

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Chapter 3
Maintenance

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⚠ Warning

Servicing described in this section is to be performed by qualified service personnel only. To avoid electrical shock, do not perform any servicing unless you are qualified to do so.

3-1. Introduction

This section of the 83, 85, 87 Service Manual provides procedures in the following areas:

- Routine and preventive maintenance.
- Performance verifications.
- Calibration.
- Troubleshooting (to the component level.)

3-2. Required Tools and Equipment

Required equipment is listed in Table 3-1. If the recommended models are not available, equipment with equivalent specifications may be used. Repairs or servicing should be performed only by qualified personnel.

3-3. Operator Maintenance

⚠ Warning

To avoid electrical shock, remove the test leads and any input signals before replacing the battery or fuses. To prevent damage or injury, install only quick acting fuses with the Amp/Volt current interrupt ratings shown in Figure 3-1.

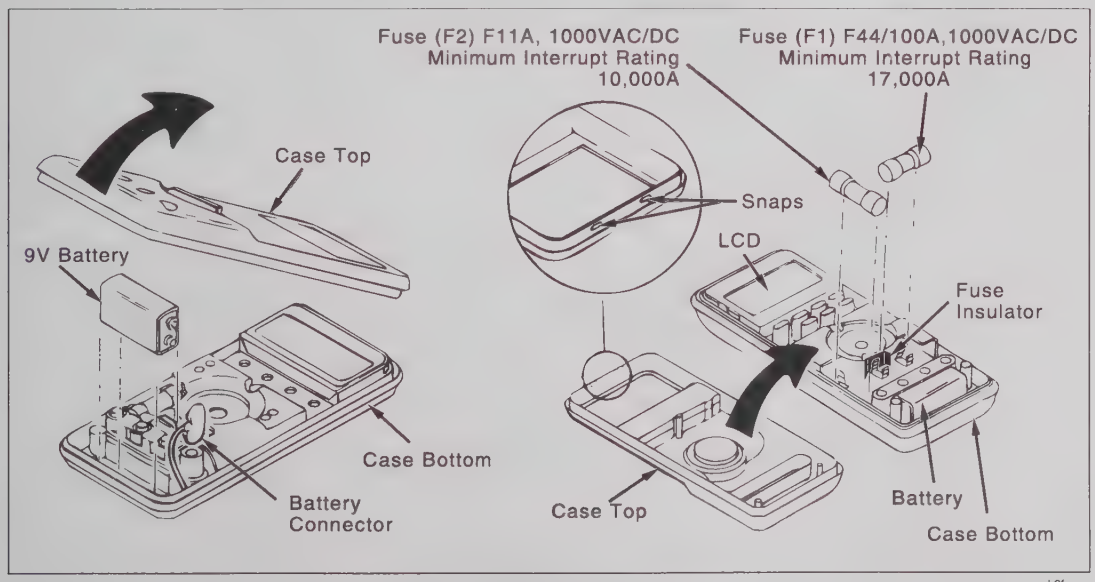

Figure 3-1. Battery and Fuse Replacement

3-4. Case Disassembly

Use the following procedure to disassemble the Multimeter.

1. Disconnect test leads from any live source, turn the rotary switch to OFF, and remove the test leads from the front terminals.
2. The case rear is secured to the case front by three screws and two internal snaps (at the LCD end). Using a Phillips-head screwdriver, remove the three screws from the case rear.

Note

The gasket between the two case halves is sealed to, and must remain with, the lower case half. The upper case half lifts away from the gasket easily. Do not damage the gasket or attempt to separate the lower case half from the gasket.

3. Now turn the case over (display side up), and, lifting up on the input terminal end, disengage the upper case half from the gasket. Gently unsnap the upper case half at the display end. See Figure 3-2.

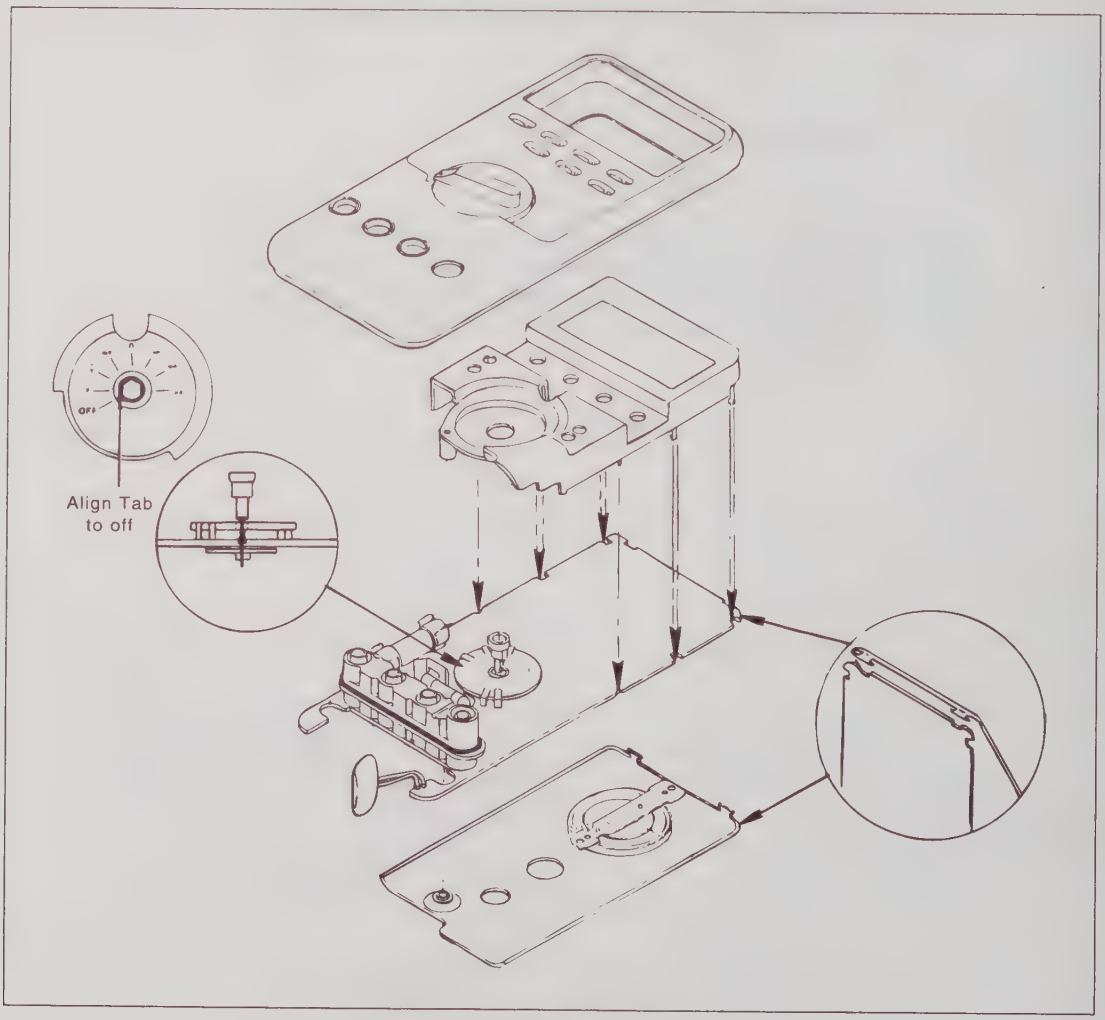

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Figure 3-2. Assembly Details

Caution

With its case removed, the Multimeter presents exposed circuit connections. To avoid unintended circuit shorting, always place the uncovered multimeter assembly on a protective surface.

Table 3-1. Required Tools and Equipment

Equipment	Required Characteristics	Recommended Model
Calibrator	AC Voltage Range: 0-1000V ac Accuracy: ±0.175% Frequency Range: 60-20000 Hz Accuracy: ±3% DC Voltage Range: 0-1000V dc Accuracy: ±0.035% Current Range: 350 µA-2A Accuracy: AC (60 Hz to 1 kHz): ±0.3% DC: ±0.1% Frequency Source: 19.999 kHz - 199.99 kHz Accuracy: ±0.0025% Amplitude: 150 mV to 6V RMS Accuracy: ±5% Range: 1Ω - 100 MΩ Accuracy: 0.065%	Fluke 5500A or equivalent

3-5. Circuit Assembly Removal and Installation

Once the outer case has been removed, the circuit assembly can b disconnected from its covering shields with the following procedure:

1. Remove the one Phillips-head screw securing the back shield to the circuit assembly. Then remove the back shield.
2. The front shield can now be disconnected from the circuit assembly by detaching the four snaps (one at a time) found on the top-front.

Caution

Be gentle when detaching or attaching the four securing snaps. Excessive force can deform or fracture the snaps.

3. To reattach the circuit assembly, push the front shield on so that the four clips engage gently and simultaneously. Then turn the assembly over, and replace the Phillips-head screw and back shield.

Note

Ensure that the shields are tightly attached. Accurate multimeter operation relies on properly fitted shields.

3-6. Case Reassembly

Use the following procedure to reassemble the Multimeter.

1. Check that the case top rotary switch and circuit board switch are in the OFF position.
2. Ensure that the gasket remains secured to the lower case half. Then, starting with the two snaps at the display end and finishing at the terminal end, cradle the upper case half into the gasket.
3. Reinstall the three screws from the lower case half.
4. Repeat the Performance Test (found in this section of the manual) after reassembly.

3-7. Battery Replacement

The meter is powered by a single 9V battery (NEDA 1604, 6F22, or 006P). Referring to Figure 3-1, use the following procedure to replace the battery:

1. Remove the multimeter case as described under Case Disassembly.
2. Lift the battery from the case bottom, and carefully disconnect the battery connector leads.
3. Snap the battery connector leads to the terminals of a new battery and reinsert the battery into the case bottom. Dress the battery leads so that they will not be pinched between the case bottom and case top.
4. Reassemble the Multimeter as described under Case Reassembly.

3-8. Fuse Test

Use the following procedure to test the internal fuses of the meter.

1. Turn the rotary selector switch to the))))Ω⊣⊢ position.
2. Plug a test lead into the VΩ→⊢ input terminal, and touch the probe to the A input terminal. Because the receptacles of the input terminals contain split contacts, be sure that you touch the probe to the half of the receptacle contact that is nearest the LCD.
3. The display should indicate between 00.0 and 00.5 ohms. This tests F2. If the display reads OL (overload), replace the fuse and test again. If the display reads any other value, further servicing is required.
4. Move the probe from the A input terminal to the mA µA input terminal.
5. The display should read between 0.995 kilohms and 1.005 kilohms. This procedure tests F1. If the display reads a high resistance or OL (overload), replace the fuse and test again. If the display reads any other value, further servicing is required.

3-9. Fuse Replacement

Referring to Figure 3-1, use the following procedure to examine or replace the meter's fuses:

1. Perform steps 1 through 3 of the battery replacement procedure.
2. Remove the defective fuse by gently prying one end of the fuse loose and sliding the fuse out of the fuse bracket.
3. Install a new fuse of the same size and rating. Make sure the new fuse is centered in the fuse holder and that the rubber/plastic fuse insulator is in place.
4. Ensure that the case top rotary switch and circuit board switch are in the OFF position.
5. Ensure that the gasket remains secured to the lower case half. Then, starting with the two snaps at the display end and finishing at the terminal end, cradle the upper case half into the gasket.
6. Reinstall the three screws from the lower case half.

3-10. Cleaning

⚠Warning

To avoid electrical shock or damage to the meter, never allow water inside the case. To avoid damaging the meter's housing, never apply solvents to the meter.

If the meter requires cleaning, wipe it down with a cloth that is lightly dampened with water or a mild detergent. Do not use aromatic hydrocarbons, chlorinated solvents, or methanol-based fluids when wiping down the meter.

3-11. Input Terminals

Water, dirt, or other contamination in the A or mA μA terminals may activate the Input Alert (beeper) feature even though test leads are not inserted. With all test leads removed, such contamination might be dislodged by turning the multimeter over and gently tapping on the case. However, the following procedure is recommended as a much more effective treatment:

1. Turn the multimeter off and remove all test leads.
2. Use a clean swab in each of the four terminals to dislodge and clean out the contamination.
3. Moisten a new swab with a cleaning and oiling agent (such as WD40). Work this swab around in each of the four terminals. Since the oiling agent insulates the terminals from moisture-related shorting, this preventive treatment ensures against future erroneous Input Alerts.

3-12. Rotary Switch

Clean the rotary knob potentiometer used by function selector switch S2 with the following procedure:

1. Remove the circuit assembly as described earlier in this section (Circuit Assembly Removal and Installation).
2. From the back of the circuit assembly, push the switch shaft in, and remove the polymer thick film (ptf) contact assembly.
3. Clean the ptf contact assembly and the potentiometer on the circuit assembly with alcohol. Blow these parts dry with clean, dry air.
4. Using a Q-tip, apply a thin film of W.F.Nye Gel Lubricant, #813S (Fluke PN 926084), to the entire surface of the ptf pattern and the hole in the center of the pattern, It is important that the grease be applied in a consistent manner, using only enough grease so that it does not accumulate on the ptf wiper contacts. Remove excess grease with a dry Q-tip. No portion of the ptf pattern should be left unlubricated.
5. Push and secure the ptf contact assembly back on the switch shaft.
6. Reassemble the circuit assembly, shields, and case parts as described earlier in the section (Case Reassembly).
7. Repeat the Performance Test after reassembly.

3-13. Performance Test

Basic operability of an 80 Series Multimeter can be checked by turning the rotary switch to Ω and connecting a test lead from the VΩ→⊣⊢ input to the mA μA input. (If you are using a test probe, touch the half of the input contact nearest the LCD.) The display should read 1.000 kΩ ± 5 digits. With the rotary switch still at Ω, test the A fuse (11A) by inserting the plug end of the test lead into the A input; then test the mA μA fuse (44/100A) by inserting the plug end of the test lead into the mA μA input. The beeper emits an Input Alert if the fuses are good.

A more involved operability and accuracy check is detailed in the following paragraphs. Each function is checked for accuracy to the specifications listed in Section 1 of this manual. Note that for performance verification purposes, the case covers do not need to be removed and no adjustments are necessary. Merely make the input connections called for, and check the display for accuracy.

3-14. Setup

Equipment setup is defined for each accuracy verification procedure. Equipment requirements are presented in Table 3-1. Accuracy figures are valid for a period of one year after calibration, when measured at an operating temperature of 18 to 28 degrees C and at a maximum of 90% relative humidity.

3-15. Display Test

Switch the meter on and compare the display with the appropriate example in Figure 3-3. Hold any button down to hold the instrument in Display Test.

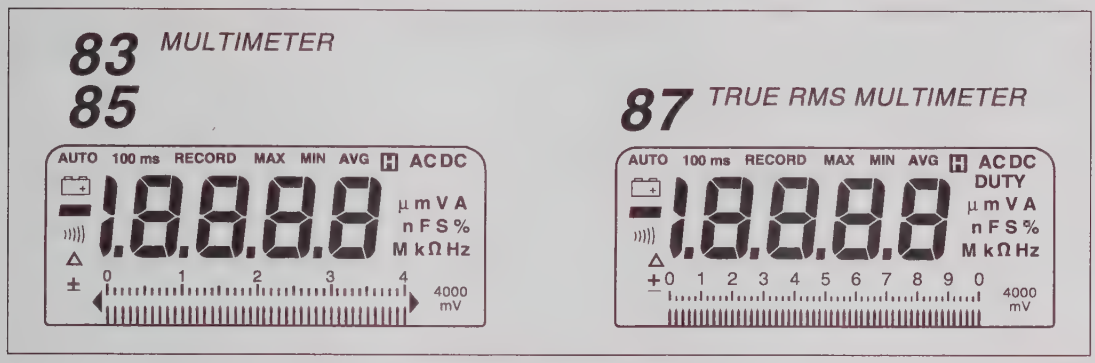

Figure 3-3. Display Test

3-16. Rotary Switch Test

This test verifies correct operation of the rotary function selector switch. Internally, the selector circuit relies on the interface between a ptf region on the circuit assembly and a rotating contact assembly on the switch shaft. The rotary switch test exercises this interface by checking the various range codes and displaying their representative numbers.

To enter the rotary switch test mode, hold down the RANGE button while turning the rotary switch from OFF to V⎓. Normal meter functions are now disabled, and a number appears in the display. Refer to Table 3-2. Continue rotating the switch one function at a time, checking for appropriate number displays. To exit the Rotary Switch mode, turn the rotary switch first to OFF, then (without holding down the RANGE button) back to any function selection.

Table 3-2. Rotary Switch Test

Function	Display (±12)	Function	Display (±12)
OFF	n/a	OHMS	-96
ACV	0	DIODE	-128
DCV	-32	mA/A	-160
mV DC	-64	µA	-192

3-17. AC Voltage Test

Use the following procedure to verify accuracy in the ac voltage ranges.

1. Connect the Calibrator to the VΩ⊣◀ and COM inputs on the Multimeter.
2. Set the Calibrator for the voltage and frequency called for in step 1 of Table 3-3. Check that the multimeter display is within the limits shown for your 80 Series Multimeter (Model 83, 85, or 87).
3. Repeat this procedure for steps 2 through 18 of Table 3-3.

Table 3-3. AC Voltage Test

Step	Input		Display Reading		
	Voltage	Frequency	83	85	87
1	350.0 mV	60 Hz	346.1 to 353.9	347.8 to 352.2	347.1 to 352.9
2	350.0 mV	1 kHz	344.3 to 355.7	346.1 to 353.9	346.1 to 353.9
3	350.0 mV	5 kHz	342.6 to 357.4	342.6 to 357.4	342.6 to 357.4
4	350.0 mV	20 kHz	NA	339.1 to 360.9	341.0 to 359.0
5	3.500V	60 Hz	3.462 to 3.538	3.480 to 3.520	3.473 to 3.527
6	3.500V	1 kHz	3.444 to 3.556	3.463 to 3.537	3.461 to 3.539
7	3.500V	5 kHz	3.427 to 3.573	3.428 to 3.572	3.426 to 3.574
8	3.500V	20 kHz	NA	3.356 to 3.644	3.410 to 3.590
9	35.00V	60 Hz	34.62 to 35.38	34.80 to 35.20	34.73 to 35.27
10	35.00V	1 kHz	34.44 to 35.56	34.63 to 35.37	34.61 to 35.39
11	35.00V	5 kHz	34.27 to 35.73	34.28 to 35.72	34.26 to 35.74
12	35.00V	20 kHz	NA	33.56 to 36.44	34.10 to 35.90
13	350.0V	60 Hz	346.2 to 353.8	348.0 to 352.0	347.3 to 352.7
14	350.0V	1 kHz	344.4 to 355.6	346.3 to 353.7	346.1 to 353.9
15	350.0V	5 kHz	342.7 to 357.3	342.8 to 357.2	342.6 to 357.4
16	100.0V	20 kHz	NA	95.6 to 104.4	96.0 to 104.0
17	900V	60 Hz	888 to 912	893 to 907	892 to 908
18	900V	1 kHz	874 to 926	880 to 920	887 to 913

3-18. Frequency Test

The following procedure verifies Multimeter accuracy in Frequency mode.

1. Connect the Calibrator to the VΩ⊣◀ and COM inputs on the Multimeter. Note that the frequency accuracy of the Calibrator used must be appropriate for the specified accuracy of the Multimeter.
2. With the Multimeter in the 400 mV ac range, press the HZ button to enter the Frequency Counter mode.
3. Set the Function Generator for the sine wave voltage and frequency called for in step 1 of Table 3-4. Check for a reading within the limits shown.

Table 3-4. Frequency Test

Step	Sine Wave Input		Display Reading 83/85/87
	Voltage	Frequency	
1	150 mV rms	19.000 kHz	18.998 to 19.002
2	150 mV rms	190.00 kHz	189.98 to 190.02

3-19. Frequency Sensitivity and Trigger Level Test

The following procedure verifies the counter sensitivity and trigger levels for all frequency modes and ranges. For any function and range, the sensitivity and trigger level is the same in both frequency and duty cycle modes.

1. Connect the meter calibrator to the VΩ→⊢ and COM inputs on the Multimeter.
2. Select the 4V ac range, and press the HZ button to choose the Frequency mode.
3. Apply the input from step 1 of Table 3-5, and check for the called-for response.
4. Select the 4V dc range, and press the Hz button to select Frequency mode.
5. Apply the input from step 2 of Table 3-5, and check for the called for response.
6. On the Multimeter, press the RANGE button to enter the 40V dc range.
7. Apply the step 3 input and check for the called-for response on the Multimeter.

Table 3-5. Frequency Counter Sensitivity and Trigger Level Tests

Step	Range	Amplitude (RMS)	Frequency	Display Reading
1	4V ac	300 mV ac	1 kHz	999.80 - 01000.2
2	4V dc	1.7V ac	1 kHz	999.8 - 1000.2
3	4V dc	1.0V ac	1 kHz	000.0
4	40V dc	6.0V ac	1 kHz	999.8 - 1000.2
5	40V dc	2.0V ac	1 kHz	000.0

3-20. DC Voltage Test

Use this procedure to verify accuracy in the dc voltage function. Note that a separate verification procedure for dc millivolts (mV) is provided later in this section.

1. Connect the Calibrator to the VΩ→⊢ and COM inputs on the Multimeter.
2. Rotate the multimeter function control to V⎓.
3. Check for the multimeter response called for in each step of Table 3-6.

Table 3-6. DC Voltage Test

Step	DC Input Voltage	Display Reading		
		83	85	87
1	3.500V	3.488 to 3.512	3.495 to 3.505	3.495 to 3.505
2	35.00V	34.88 to 35.12	34.95 to 35.05	34.95 to 35.05
3	-35.00V	-34.88 to -35.12	-34.95 to -35.05	-34.95 to -35.05
4	350.0V	348.8 to 351.2	349.5 to 350.5	349.5 to 350.5
5	1000V	996 to 1004	998 to 1002	998 to 1002

3-21. 1-MS MIN MAX Test (Model 87 only)

The following procedure checks the minimum/maximum hold feature of the Model 87 Multimeter.

1. Apply 2.0V ac at 60 Hz (step 1, Table 3-7) from the Calibrator to the VΩ→⊣⊢ and COM inputs of the Multimeter. Prior to entering the MIN MAX mode, rotate the function selector knob to either dc volts (for dc coupling of the input) or ac volts (for capacitive coupling of the input).

   Note

   The rms converter is not used in Peak mode. The digital display represents the actual peak value of the input.

2. Press the MIN MAX button to enter the Min/Max mode.
3. Press the beeper button to both enter the 1-millisecond mode and begin display of maximum values.
4. Check for the maximum reading called for in step 1 of Table 3-7.
5. Press the MIN MAX button to begin display of minimum values.
6. Check for the minimum reading called for in step 2 of Table 3-7.

Table 3-7. 1-MS MIN MAX Test

Step	AC Input		Display Reading		
	Voltage	Frequency	83	85	87
1	2.0V	60 Hz	n/a	n/a	2.765 to 2.890
2	2.0V	60 Hz	n/a	n/a	-2.765 to -2.890

3-22. mV DC Tests

The following test verifies accuracy in the dc millivolt ranges.

1. Connect the Calibrator to the VΩ→⊣⊢ and COM inputs on the Multimeter.
2. Set the Multimeter to the m⎓ function.
3. Apply 350.0 mV and check for the appropriate multimeter display, as follows:

Model 83	348.8 to 351.2
Model 85	349.5 to 350.5
Model 87	349.5 to 350.5

3-23. Ohms Tests

Use the following procedure to verify resistance measurement accuracy.

1. Connect the Resistance Calibrator to VΩ→⊣⊢ and COM on the Multimeter.
2. Rotate the multimeter function selector to Ω.
3. Check for the required display for each input called for in steps 1 through 5 of Table 3-8.
4. Press the RANGE button on the Multimeter to enter the 40-nanosiemen range, used for conductance tests of high resistances. Then proceed with step 6 of Table 3-8.

Table 3-8. Ohms Tests

Step	Resistance	Display Reading		
		83	85	87
1	short	Push REL Δ to zero any offset		
2	190.0Ω	189.0 to 191.0	189.4 to 190.6	189.4 to 190.6
3	19.00 kΩ	18.91 to 19.09	18.95 to 19.05	18.95 to 19.05
4	1.900 MΩ	1.886 to 1.914	1.888 to 1.912	1.888 to 1.912
5	19.00 MΩ	18.78 to 19.22	18.78 to 19.22	18.78 to 19.22
6	100.0 MΩ	9.80 to 10.20	9.80 to 10.20	9.80 to 10.20

3-24. Capacitance Tests

The Multimeter measures capacitance by charging the capacitor with a known direct current, measuring the resultant voltage, and calculating the capacitance. If the same capacitance is measured on an impedance bridge, a different reading may result. This variance is likely to be greater at higher frequencies.

The following procedure verifies the capacitance measuring accuracy of your Multimeter.

1. Connect the Calibrator to the VΩ⊣⊢ and COM inputs on the Multimeter.
2. For steps 1 through 3 in Table 3-9, turn the rotary switch to))))Ω⊣⊢, press the blue button, connect the test leads to the capacitor, and check for the appropriate display on your Multimeter. The meter selects the proper range automatically. Each measurement takes about one second per range.
3. For step 4, first use the Relative mode (REL) to zero the display and automatically subtract the residual meter and test lead capacitance. Note that the Relative mode puts the multimeter into manual ranging.

Table 3-9. Capacitance Tests

Step	Capacitance	Display Reading		
		83	85	87
1	1.0 µF	0.95 to 1.05	0.95 to 1.05	0.95 to 1.05
2	0.470 µF	0.463 to 0.477	0.463 to 0.477	0.463 to 0.477
3	0.0470 µF	0.0463 to 0.0477	0.0463 to 0.0477	0.0463 to 0.0477
4	4.70 nF	4.62 to 4.78	4.62 to 4.78	4.62 to 4.78

3-25. Diode Test

Use the following procedure to check the diode function:

1. Rotate the multimeter function selector to ⊣⊢.
2. Connect the Calibrator to the VΩ⊣⊢ and COM inputs on the Multimeter.

Note

On Fluke 5100 series calibrators, activate the 50Ω divider override.

3. Apply 3.000V, and look for a display response of 3.000 +/- 0.061V dc.

3-26. mA Tests

The following procedure verifies accuracy of both ac and dc current measurement when the multimeter function selector is set to [mA/A≂].

1. Connect the Calibrator to the mA μA and COM inputs on the Multimeter.
2. Set the multimeter function to [mA/A≂].
3. Perform steps 1 and 2 in Table 3-10, checking for the appropriate multimeter display for each input.
4. Press the blue button on the Multimeter to toggle to ac current measurement.
5. Perform steps 3 through 6 in Table 3-10, checking for the appropriate multimeter display for each input.

Table 3-10. mA Tests

Step	DC Current		Display Reading		
			83	85	87
1	35.00 mA		34.84 to 35.16	34.91 to 35.09	34.91 to 35.09
2	350.0 mA		348.4 to 351.6	349.1 to 350.9	349.1 to 350.9
	AC Current	Frequency	83	85	87
3	35.00 mA	60 Hz	34.56 to 35.44	34.77 to 35.23	34.63 to 35.37
4	35.00 mA	1.0 kHz	34.56 to 35.44	34.77 to 35.23	34.63 to 35.37
5	350.0 mA	60 Hz	345.6 to 354.4	347.7 to 352.3	346.3 to 353.7
6	350.0 mA	1.0 kHz	345.6 to 354.4	347.7 to 352.3	346.3 to 353.7

3-27. μA Tests

The following test verifies accuracy in the microamp (μA) measurement mode.

1. Connect the Calibrator to the mA μA and COM inputs on the Multimeter.
2. Rotate the multimeter function selector to μA≂.
3. Verify correct display readings for the given dc inputs in steps 1 and 2 of Table 3-11.
4. Press the blue button on the Multimeter to enable ac measurements.
5. Check for the appropriate multimeter readings for steps 3 through 6 of Table 3-11.

Table 3-11. μA Tests

Step	DC Current		Display Reading		
			83	85	87
1	350.0 μA		348.3 to 351.7	349.0 to 351.0	349.0 to 351.0
2	3500 μA		3484 to 3516	3491 to 3509	3491 to 3509
	AC Current	Frequency	83	85	87
3	350.0 μA	60 Hz	345.6 to 354.4	347.7 to 352.3	346.3 to 353.7
4	350.0 μA	1.0 kHz	345.6 to 354.4	347.7 to 352.3	346.3 to 353.7
5	3500 μA	60 Hz	3456 to 3544	3477 to 3523	3463 to 3537
6	35.0 μA	1.0 kHz	3456 to 3544	3477 to 3523	3463 to 3537

3-28. A Tests

Use the following procedure to verify measurement accuracy in the ampere ([A]) mode.

1. If necessary, set the calibrator output to 0.
2. Rotate the multimeter function selector to mA/A≂.
3. Connect the Calibrator to the [A] and COM inputs of the Multimeter.
4. Perform steps 1 and 2 in Table 3-12. For each input, check that a display appropriate for your Multimeter is obtained.
5. Set the calibrator output to 0. Now press the blue button on the Multimeter to toggle to ac current measurement once again.
6. Perform steps 3 through 6 in Table 3-12.

Table 3-12. A Tests

Step	DC Current		Display Reading		
			83	85	87
1	3500 mA		3484 to 3516	3491 to 3509	3491 to 3509
2	10.00A		9.94 to 10.06	9.96 to 10.04	9.96 to 10.04
	AC Current	Frequency	83	85	87
3	3500 mA	60 Hz	3456 to 3544	3477 to 3523	3463 to 3537
4	3500 mA	1.0 kHz	3456 to 3544	3477 to 3523	3463 to 3537
5	10.00A	60 Hz	9.86 to 10.14	9.92 to 10.08	9.88 to 10.12
6	10.00A	1.0 kHz	9.86 to 10.14	9.92 to 10.08	9.88 to 10.12

3-29. Calibration

Calibrate the meter once a year to ensure that it performs according to specifications. Connect the Calibrator to the VΩ→⊢ and COM inputs on the Multimeter. Calibration adjustment points are identified in Figure 3-4. The slightly different routines required for each model of the 80 Series are presented in the following paragraphs.

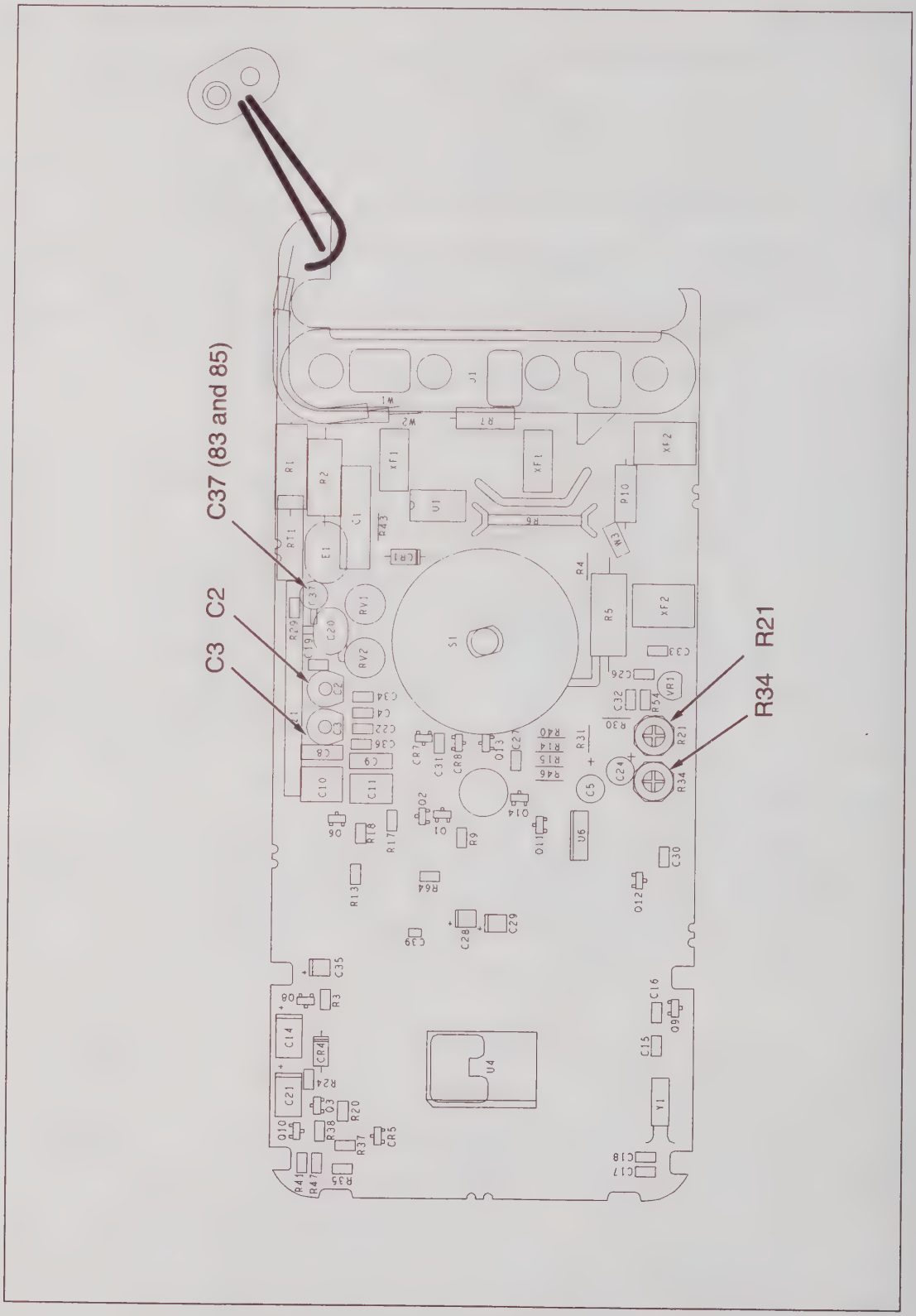

Figure 3-4. Calibration Adjustment Points

3-30. Models 83 and 85 Calibration

Calibrate the Fluke 83 or 85 with the following procedure:

1. Set the source for VDC, 0V.
2. On the multimeter, select the V⎓ function.
3. Connect the source to the VΩ→⊣⊢ and COM inputs on the multimeter.
4. Set the source for 3.500V dc output.
5. The multimeter should now display 3.500 +/-0.001. If necessary, adjust R21 to obtain the proper display.
6. Now set the multimeter to the V~ function, then set the source for an output of 3.500V at 100 Hz.
7. The multimeter should now display 3.500 ±0.002. If necessary, adjust R34 to obtain the proper display.

Note

For the Fluke 85, set the source for 100V at 20 kHz. The Fluke 85 should now display 100.0 ± 0.2. If necessary, adjust C37 to obtain the proper display.

8. Set the source for an output of 3.500V at 10 kHz.
9. The multimeter should now display 3.500 ±0.004. If necessary, adjust C2 to obtain the proper display.
10. Set the source for an output of 35.00V at 10 kHz.
11. The multimeter should now display 35.00 ±0.04. If necessary, adjust C3 to obtain the proper display.

3-31. Model 87 Calibration

Calibrate the Fluke 87 with the following procedure:

1. Set the source for VDC, 0V.
2. On the Model 87, select the V⎓ function.
3. Connect the source to the Model 87 VΩ→⊣⊢ and COM inputs.
4. Set the source for 3.500V dc output.
5. The Model 87 should now display 3.500 ±0.001. If necessary, adjust R21 to obtain the proper display.
6. Now set the Model 87 to the V~ function, then set the source for an output of 3.513V at 50 Hz.

Note

The disparity of 3.513 in step 6, and display of 3.500 in step 7, is due to compensation for the RMS converter linearity.

7. The Model 87 should now display 3.500 ±0.002. If necessary, adjust R34 to obtain the proper display.
8. Set the source for 100V at 20 kHz.

9. The Model 87 should now display 100.0 ±0.2. If necessary, adjust C37 to obtain the proper display.
10. Set the source for an output of 3.500V at 10 kHz.
11. The Model 87 should now display 3.500 ±0.004. If necessary, adjust C2 to obtain the proper display.
12. Set the source for an output of 35.00V at 10 kHz.
13. The Model 87 should now display 35.00 ±0.04. If necessary, adjust C3 to obtain the proper display.

3-32. Troubleshooting

If the meter fails, check the battery and fuses and replace as needed. If problems persist, verify that you are operating the meter correctly by reviewing the operating instructions found in the User's Manual. If these measures suggest a fault with the multimeter, consult the power supply troubleshooting procedures in this section and the schematic diagrams in Section 5 of this manual.

3-33. Servicing Surface-Mount Assemblies

The 80 Series multimeters incorporate Surface-Mount Technology (SMT) for printed circuit assemblies (pca's). Surface-mount components are much smaller than their predecessors, with leads soldered directly to the surface of a circuit board; no plated through-holes are used. Unique servicing, troubleshooting, and repair techniques are required to support this technology. The information offered in the following paragraphs serves only as an introduction to SMT. It is not recommended that repair be attempted based only on the information presented here.

Since sockets are seldom used with SMT, "shotgun" troubleshooting cannot be used; a fault should be isolated to the component level before a part is replaced. Surface-mount assemblies are probed from the component side. The special probes make contact only with the pads in front of the component leads. With the close spacing involved, ordinary test probes can easily short two adjacent pins on an SMT IC.

This Service Manual is a vital source for component locations and values. With limited space on the circuit board, chip component locations are seldom labeled. Figures provided in Section 4 of this manual provide this information. Also, remember that chip components are not individually labeled; keep any new or removed component in a labeled package.

Surface-mount components are removed and replaced by reflowing all the solder connections at the same time. Special considerations are required.

- The solder tool uses regulated hot air to melt the solder; there is no direct contact between the tool and the component.
- Surface-mount assemblies require rework with wire solder rather than with solder paste. A 0.025 inch diameter wire solder composed of 63% tin and 37% lead is recommended. A 60/40 solder is also acceptable.
- A good connection with SMT requires only enough solder to make a positive metallic contact. Too much solder causes bridging, while too little solder can cause weak or open solder joints. With SMT, the anchoring effect of the through-holes is missing; solder provides the only means of mechanical fastening. Therefore, the pca must be especially clean to ensure a strong connection. An oxidized pca pad causes the solder to wick up the component lead, leaving little solder on the pad itself.

3-34. Troubleshooting - Power Supply

The two regulator circuits are interrelated; a malfunction in either the common regulator or the Vdd regulator may cause a problem in the other. Refer to Tables 3-13 and 3-14 for descriptions of power supply components and voltage levels, respectively. To isolate the problem regulator circuit, disconnect the battery, and drive Vdd - Vss = 6.2V with a power supply. This procedure tests the common regulator independently of the Vdd regulator.

Now check for Vdgnd - Vss = -3.2V ±0.3V. If this test is successful, the problem lies with the Vdd regulator; refer to Vdd Regulator Troubleshooting later in this section. If this test is not successful, the problem lies with the common regulator; continue with the Common Regulator Troubleshooting below.

Note that if the common regulator works or has been repaired, check both supplies with the 9V battery supply.

Table 3-13. Functional Description of Power Supply Components

Components	Function
R24, R25	Vdd Regulator series regulator device
Q8	Power on/off device
Q10	Power supply startup device. Q10 provides Q8 base startup current. Q10 is always off during meter operation.
CR5	CR5 is in the power supply series loop, allowing for generation of Vbt = +3.6V for diode test.
VR1	VR1 provides the system reference voltage. It is used for the A/D Converter reference and as a reference for both power supply regulators.
C14	Vdd regulator compensation and bypass.
C21	Common regulator compensation and bypass
C35	Battery and CR5 bypass.
C32	Q8 gate bypass.
R24, R25	Vdd regulator voltage sensing resistors.
R37, R38	Common regulator voltage sensing resistors
R44	Supplies bias current to VR1.
R54	Q8 gate pull-up resistor.

Table 3-14. Voltage Levels

VDD	3.0 ±0.3
VSS	3.2 ±0.3
VBT+	3.5 ±0.3
VBT-	5.5 (battery at full 9V charge) 3.0 (battery at low charge of 6.5V)
REFH	1.235 ±0.012
PS0	1.235 ±0.15
PS1	0 ±0.15
AP6	-0.5 to -0.15
VOA	2.2 to 1.7 (referenced from VSS)
VOB	1.07 to .85 (referenced from VSS)

3-35. Common (Shunt) Regulator Troubleshooting

To troubleshoot the common regulator, connect the power supply so that Vdd, Vss, and DGND (digital ground) are supplied from an external power supply. This procedure over-drives the large on-chip shunt transistors; the bias current from the power supply ranges from 10 mA to 100 mA. Refer to Figure 3-5 for a simplified diagram of the common regulator. Make the following tests:

1. Check for +1.235V ±20 mV (Vrefh) at the cathode of VR1. If Vrefh is not correct, check VR1, R19, R20, and R44 and the traces to these parts carefully. If Vrefh is still incorrect, U4 is bad.
2. If Vrefh is correct, measure the voltage at U4 pin 6 (PS1). If Vps1 is not equal to 0V ±0.15V, check R37 and R38 and their associated traces. If Vps1 is still at an incorrect voltage, U4 is bad.
3. A DGND and Vss current much larger than 100 mA may indicate a problem with Q12 (Vdgnd-to-Vss quick turn-off clamp) or its base drive signal from U6. The Q12 clamp is off when the instrument is on and on when the instrument is off.
4. Check the bias generator circuit. With the exception of resistor R35 (620 kΩ), the bias generator (which sets the bias level for all U4 analog circuitry) is internal to U4. A problem with this circuit could cause the on-chip power supply op amps to not work. Measure the dc voltage between U4 pin 8 (Vbias) and DGND. If -0.2V <Vbias > +0.2V the bias generator is okay. If Vbias is not correct, check R35. If Vbias is still wrong, replace U4.
5. Measure the ac voltage between Vdgnd and Vss. If it is greater than 10 mV ac, check C21. (An open C21 causes common regulator instability.) The dc level may also be incorrect.
6. If the common regulator still does not work, circuitry internal to U4 is bad. Replace U4.

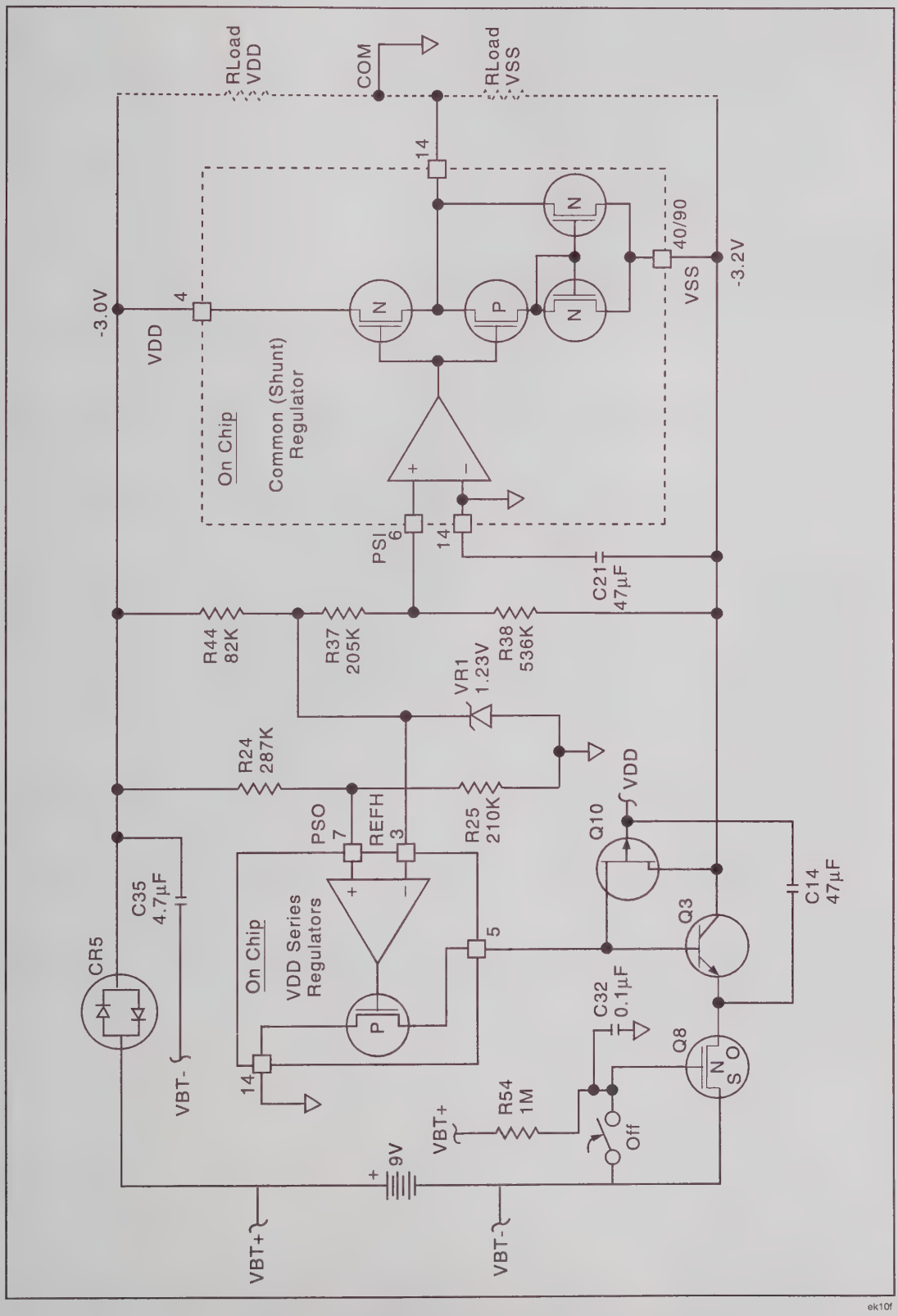

Figure 3-5. Simplified Power Supply Schematic

3-36. Vdd (Series) Regulator Troubleshooting

If a problem still exists after the common regulator troubleshooting, continue on with the following Vdd regulator troubleshooting. Often, a short or sneak current path causes power supply problems. Refer to Figure 3-5 for a simplified diagram of the Vdd (Series) Regulator. Make the following tests:

1. Measure the dc operating current from the 9V battery. If it is greater than 1.2 mA for an 83/85 or greater than 1.4 mA for an 87, a sneak current path exists. A sneak current path can be very difficult to find.
2. First, visually check for both solder bridges on U4 pins and other circuit board shorts.

Isolate the current path at the negative battery terminal (Vbt-). The components connected to Vbt- are C35, CR4, R56, U6, Q8, and the rotary knob "fingers". Remove these parts one at a time (except Q8). Measure I(bat) after each removal to isolate the problem.

1. If the excess battery current stops after removing R56, either R56, R57, Q9, or Q11 may be bad. If one of these four parts is bad a problem may not be noticed until U6 is removed.
2. If the extra current is still present with all parts except Q8 removed, remove Q10 and check for excess battery current. If I(bat) is now correct, Q10 is bad. If I(bat) is still excessive, U4 is probably at fault.

If the power supply is not working, but battery current is normal, perform the following tests.

1. With the 9V battery attached, cycle the unit off and on. If both supplies are less than 1.0V, a problem probably exists with the on/off circuit. Check Q8, R54, and C32.
2. Check the rotary knob wiper contacts; verify that the Q8 gate voltage is close to Vbt+.
3. If Vdd - Vss is low, a problem may exist with start up device Q10. Check Q10 by momentarily connecting Vss to Vbt-. If both Vss and Vbt- now start up and operate correctly, check Q10 for an open.
4. Measure the ac voltage between Vdd and Vss. An unstable Vdd regulator can be caused by an open C14. If it is greater than 10 mV ac, check C14. The dc level may also be incorrect.

For a final check of U4, remove the battery and supply Vdd = +3.0V, Vdgnd = 0, and Vss = -3.2V from an external power supply. Measure the voltage at U4 pin 7 (Vps0). If it does not equal 1.235V ±0.15V then check R24 and R25 carefully. If Vps0 is still incorrect, U4 is bad.

Chapter 4
List of Replaceable Parts

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4-1. Introduction

This section contains an illustrated list of replaceable parts for the 83, 85, and 87 Multimeters. Parts are listed by assembly; alphabetized by reference designator. Each assembly is accompanied by an illustration showing the location of each part and its reference designator. The parts lists give the following information:

- Reference designator
- An indication if the part is subject to damage by static discharge
- Description
- Fluke stock number
- Total quantity
- Any special notes (i.e., factory-selected part)

Caution

A * symbol indicates a device that may be damaged by static discharge.

4-2. How to Obtain Parts

Electrical components may be ordered directly from the manufacturer by using the manufacturers part number, or from the Fluke Corporation and its authorized representatives by using the part number under the heading Fluke Stock No. In the U.S., order directly from the Fluke Parts Dept. by calling 1-800-526-4731. Parts price information is available from the Fluke Corporation or its representatives. Prices are also available in a Fluke Replacement Parts Catalog which is available on request.

In the event that the part ordered has been replaced by a new or improved part, the replacement will be accompanied by an explanatory note and installation instructions, if necessary.

To ensure prompt delivery of the correct part, include the following information when you place an order:

- Part number and revision level of the pca containing the part.
- Reference designator
- Fluke stock number
- Description (as given under the Description heading)
- Quantity
- Instrument Model, Serial Number, and Firmware Numbers

4-3. Manual Status Information

The Manual Status Information table that precedes the parts lists defines the assembly revision levels that are documented in the manual. Revision levels are printed on the component side of each pca.

4-4. Newer Instruments

Changes and improvements made to the instrument are identified by incrementing the revision letter marked on the affected pca. These changes are documented on a manual supplement which, when applicable, is included with the manual.

4-5. Service Centers

To locate an authorized service center, call Fluke Corporation at:

800-443-5853 in U.S.A. and Canada
31-40-2678200 in Europe
206-356-5500 from other countries

Note

This instrument may contain a Nickel-Cadmium battery. Do not mix with the solid waste stream. Spent batteries should be disposed of by a qualified recycler or hazardous materials handler. Contact your authorized Fluke service center for recycling information.

Manual Status Information

Ref.Des	Assembly Name	Fluke Part No.	Revision Level
A1	Main PCA (83)	819284	W
A1	Main PCA (85)	819276	AC
A1	Main PCA (87)	819268	AG

Table 4-1. Fluke 83 Final Assembly

Reference Designator		Description	Fluke Stock No	Tot Qty	Notes
A1	*	MAIN PCA	857870	1	
BT1		BATTERY,PRIMARY,ALKALINE,9V,0-200MA	614487	1	
E1		CONTACT,PTF	822676	1	
E2		CONTACT,ANNUNCIATOR	822791	1	
F1		FUSE,.406X1.375,0.440A,1000V,FAST	943121	1	
F2		FUSE,.406X1.5,11A,1000V,FAST	943118	1	
H1		SCREW,PH,P,THD FORM,STL,4-14,.562	832220	1	
H2		SCREW,PH,P,AM THD FORM,STL,5-14,.750	832246	3	
J1,J2		CONN,ELASTOMERIC,LCD TO PWB,1.590 L	817460	2	
MP1		MASK,LCD (PAD XFER)	930284	1	
MP2		SHIELD,TOP	824516	1	
MP3		SHAFT,SWITCH	822635	1	
MP4		SHIELD,BOTTOM, W/ BEEPER	824524	1	
MP5		CASE TOP (PAD XFER), W/WINDOW - CE	617305	1	1,3
MP6		CASE & GASKET ASSY, BOTTOM W/FUSES	617289	1	3
MP8		KNOB,SWITCH (PAD XFER)	880815	1	
MP9		SPRING,DETENT	822643	1	
MP10		FOOT,NON SKID	824466	2	
MP13		SHOCK ABSORBER	828541	1	
MP14		O-RING,NITRILE N674-70,1.670,.047	831933	1	
MP15		HOLSTER & FLEXSTAND ASSY YELLOW	822809	1	
MP19		TEST LEADS	855742	1	
MP21		INSULATOR, FUSE	203064	1	
S1		SWITCH PAD, MOMENTARY	809988	1	
TM1		FLUKE 83/85/87 SERVICE MANUAL	617826	0	2
TM5		FLUKE 83/85 USERS MANUAL (ENGLISH)	852426	1	
TM6		FLUKE 83/85 USERS MANUAL (INTERNATIONAL)	852434	1	
U5		LCD,4.5 DIGIT,BAR GRAPH,MULTIPLEXED	782763	1	

1. MP5 INCLUDES MP8 AND MP9.
2. AVAILABLE UPON REQUEST.
3. FOR SAFETY REASONS, DO NOT USE THE CASE TOP OR BOTTOM ON FLUKE 83 UNITS WITH PCA REVISION LEVELS BELOW "W".

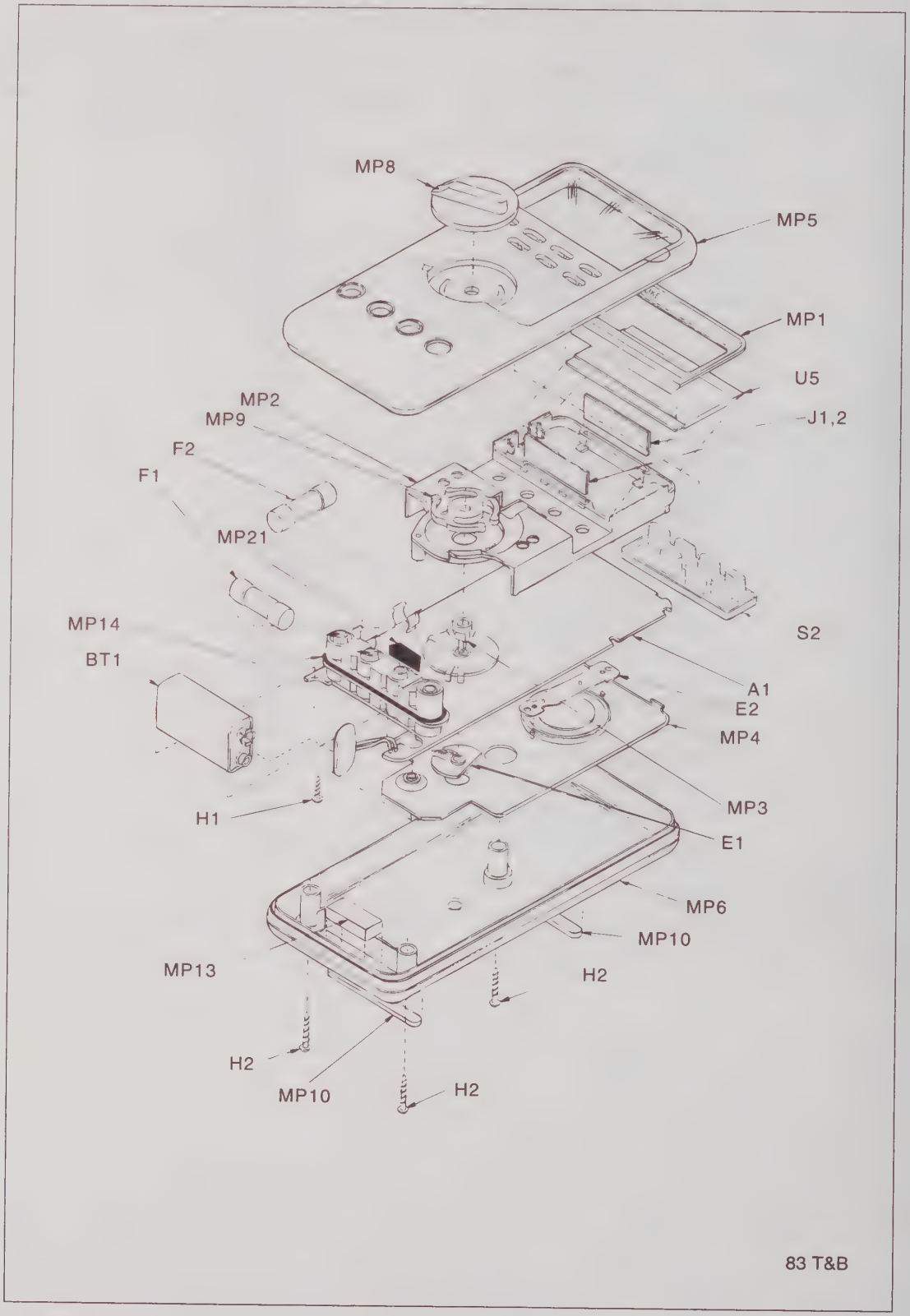

Figure 4-1. Fluke 83 Final Assembly

Table 4-2. Fluke 83 A1 Main PCA

Reference Designator		Description	Fluke Stock No	Tot Qty	Notes
C1		CAP,POLYES,0.01UF,+-10%,1000V	822361	1	
C2		CAP,VAR,3-11PF,100V,CER	641712	1	
C3		CAP,VAR,9-90PF,50V,CER	643130	1	
C4		CAP,CER,470PF,+-5%,50V,C0G,1206	943365	1	
C5		CAP,TA,15UF,+-20%,6.3V	807636	1	
C8,C9		CAP,POLYCA,0.027UF,+-10%,63V	720979	2	
C10		CAP,POLYES,0.47UF,+-10%,50V	697409	1	
C11		CAP,POLYPR,0.022UF,+-10%,63V	821579	1	
C14,C21		CAP,TA,47UF,+-20%,10V,7343	867580	2	
C15,C16,C32		CAP,CER,0.1UF,+-10%,25V,X7R,1206	747287	3	
C17,C18		CAP,CER,22PF,+-10%,50V,C0G,1206	740563	2	
C19		CAP,CER,12PF,+-10%,50V,C0G,1206	747329	1	
C20		CAP,CER,5.6PF,+-0.25PF,1500V,C0H	851811	1	
C22		CAP,CER,1000PF,+-10%,50V,C0G,1206	747378	1	
C24		CAP,TA,10UF,+-20%,10V	714766	1	
C26,C31,C33,		CAP,CER,0.01UF,+-10%,50V,X7R,1206	747261	4	
C34			747261		
C27		CAP,CER,120PF,+-5%,50V,C0G,1206	854141	1	
C28,C29		CAP,TA,0.47UF,+-20%,35V,3528	867259	2	
C30		CAP,CER,220PF,+-10%,50V,C0G,1206	758078	1	
C35		CAP,TA,4.7UF,+-20%,10V,3528	867262	1	
C36		CAP,CER,68PF,+-10%,50V,C0G,1206	853861	1	
C39		CAP,CER,150PF,+-5%,50V,C0G,0805	866533	1	
CR1,CR4		DIODE,SI,1K PIV,1.0 AMP	707075	2	
CR5,CR7,	*	DIODE,SI,BV=70V,IO=50MA,DUAL,SOT-23	742320	3	
CR8			742320		
E1		SURGE PROTECTOR,1500V,+-20%	655134	1	
J1		INPUT RCPT ASSY	826214	1	
Q1,Q2,Q6	*	TRANSISTOR,SI,NPN,25V,0.3W,SEL,SOT-23	821637	3	
Q3,Q9,Q12	*	TRANSISTOR,SI,NPN,60V,350MW,SOT-23	742676	3	
Q8	*	TRANSISTOR,SI,N-DMOS FET,SOT-23	927538	1	
Q10	*	TRANSISTOR,SI,P-CHAN,SOT-23	832477	1	
Q11	*	TRANSISTOR,SI,PNP,40V,300MW,SOT-23	742684	1	
Q13,Q14	*	TRANSISTOR,SI,NPN,55V,225MW,SOT-23	912469	2	
R1		RES,WW,3.5K,+-5%,5W,20PPM	107695	1	3
R2	*	RES,CERM,909K,+-1%,2W,100PPM	831594	1	3
R3	*	RES,CERM,1.5K,+-5%,.125W,200PPM	746438	1	
R4		RES,MF,110.1,+-0.1%,0.125W,100PPM	821728	1	
R5		RES,WW,0.9905,+-0.1%,2.5W	821645	1	
R6		RES,WW,.010,+-.1%,1W,100PPM	807305	1	
R7,R10	*	RES,CERM,5.1M,+-5%,1W,200PPM	601796	2	
R8	*	RES,CERM,15M,+-5%,.125W,300PPM	811968	1	
R9,R13,R29	*	RES,CERM,100K,+-5%,.125W,200PPM	740548	3	
R11	*	RES,CERM,10M,+-5%,.125W,300PPM	783274	1	
R12,R65-70	*	RES,CERM,10K,+-5%,.125W,200PPM	746610	7	
R14		RES,MF,10K,+-0.1%,0.125W,100PPM	658955	1	

Table 4-2. Fluke 83 A1 Main PCA (cont)

Reference Designator		Description	Fluke Stock No	Tot Qty	Notes
R15		RES,MF,90K,+-0.1%,0.125W,100PPM	658906	1	
R17,R18,R54	*	RES,CERM,1M,+-5%,.125W,200PPM,1206	746826	3	
R19	*	RES,CERM,56.2K,+-1%,.125W,100PPM	831305	1	
R20,R37	*	RES,CERM,205K,+-1%,.125W,100PPM	769836	2	
R21	*	RES,VAR,CERM,100K,+-20%,.3W	649897	1	
R24	*	RES,CERM,324K,+-1%,.125W,100PPM	911243	1	
R25	*	RES,CERM,210K,+-1%,.125W,100PPM	821660	1	
R30		RES,MF,20K,+-0.25%,0.125W,50PPM	715029	1	
R31,R40		RES,MF,22.6K,+-0.25%,0.125W,50PPM	715011	2	
R34	*	RES,VAR,CERM,1K,+-20%,.3W	831420	1	
R35	*	RES,CERM,665K,+-1%,.125W,100PPM	867460	1	
R38	*	RES,CERM,536K,+-1%,.125W,100PPM	845420	1	
R41,R47	*	RES,CERM,0,+.05 MAX,.125W,1206	810747	2	
R42	*	RES,CERM,1M,+-5%,.125W,200PPM,1206	746826	1	
R43		RES,MF,1K,+-0.1%,0.125W,100PPM	821694	1	
R44	*	RES,CERM,82K,+-5%,.125W,200PPM	811794	1	
R46		RES JUMPER,0.02,0.25W	682575	1	
R48	*	RES,CERM,5.1M,+-5%,.125W,300PPM	876490	1	
R56,R57	*	RES,CERM,22K,+-5%,.125W,200PPM	746651	2	
R58	*	RES,CERM,120K,+-5%,.125W,200PPM	746719	1	
R59	*	RES,CERM,510,+-5%,.125W,200PPM	746388	1	
R62	*	RES,CERM,100K,+-5%,.125W,200PPM	740548	1	
R63	*	RES,CERM,1K,+-5%,1W,200PPM,2512	601176	1	
R64	*	RES,CERM,10K,+-5%,.125W,200PPM	746610	1	
RT1		THERMISTOR,RECT,POS,1.5K,+-30%	822015	1	3
RV1,RV2		VARISTOR,910,+-10%,1.0MA	876193	2	3
S1		SWITCH,ROTARY	819334	1	
U1		DIODE,SI,RECT,BRIDGE,BV=50V,IO=1A	418582	1	
U4		SMX2 OLY 85 IC	921601	1	
U6	*	IC,CMOS,HEX INVERTER,SOIC	838375	1	
VR1	*	IC, 1.23V,150 PPM T.C.,BANDGAP V. REF	634451	1	
W1		JUMPER WIRE NEG	834994	1	
W2		JUMPER WIRE,POS	835009	1	
W3		WIRE, JUMPER	203067	1	
XBT1		CONNECTOR,BATTERY	825976	1	
XF1		FUSE CONTACT	659524	2	1
XF2		FUSE CONTACT	707190	2	2
Y1		CRYSTAL,131.072KHZ,0.003%,3X8MM	831453	1	
Z1		RNET,CERM,SIP,FLUKE 83 HI V DIVIDER	828152	1	

1. REF.DES XF1 IS TWO (2) PARTS. THEY ARE USED WITH F1 ON THE FINAL ASSEMBLY.
2. REF.DES XF2 IS TWO (2) PARTS. THEY ARE USED WITH F2 ON THE FINAL ASSEMBLY.
3. TO ENSURE SAFETY, USE EXACT REPLACEMENT ONLY.

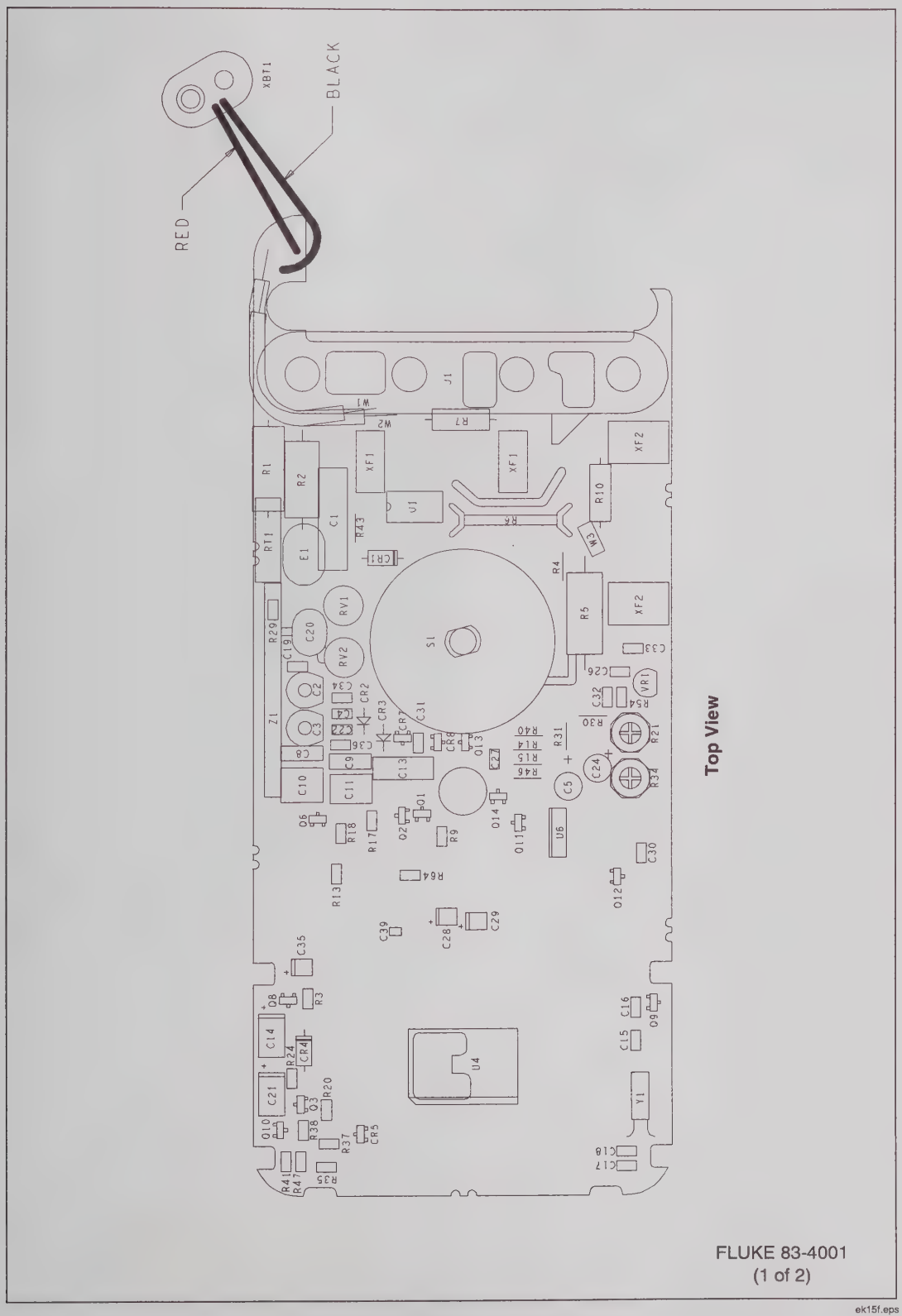

Figure 4-2. Fluke 83 A1 Main PCA

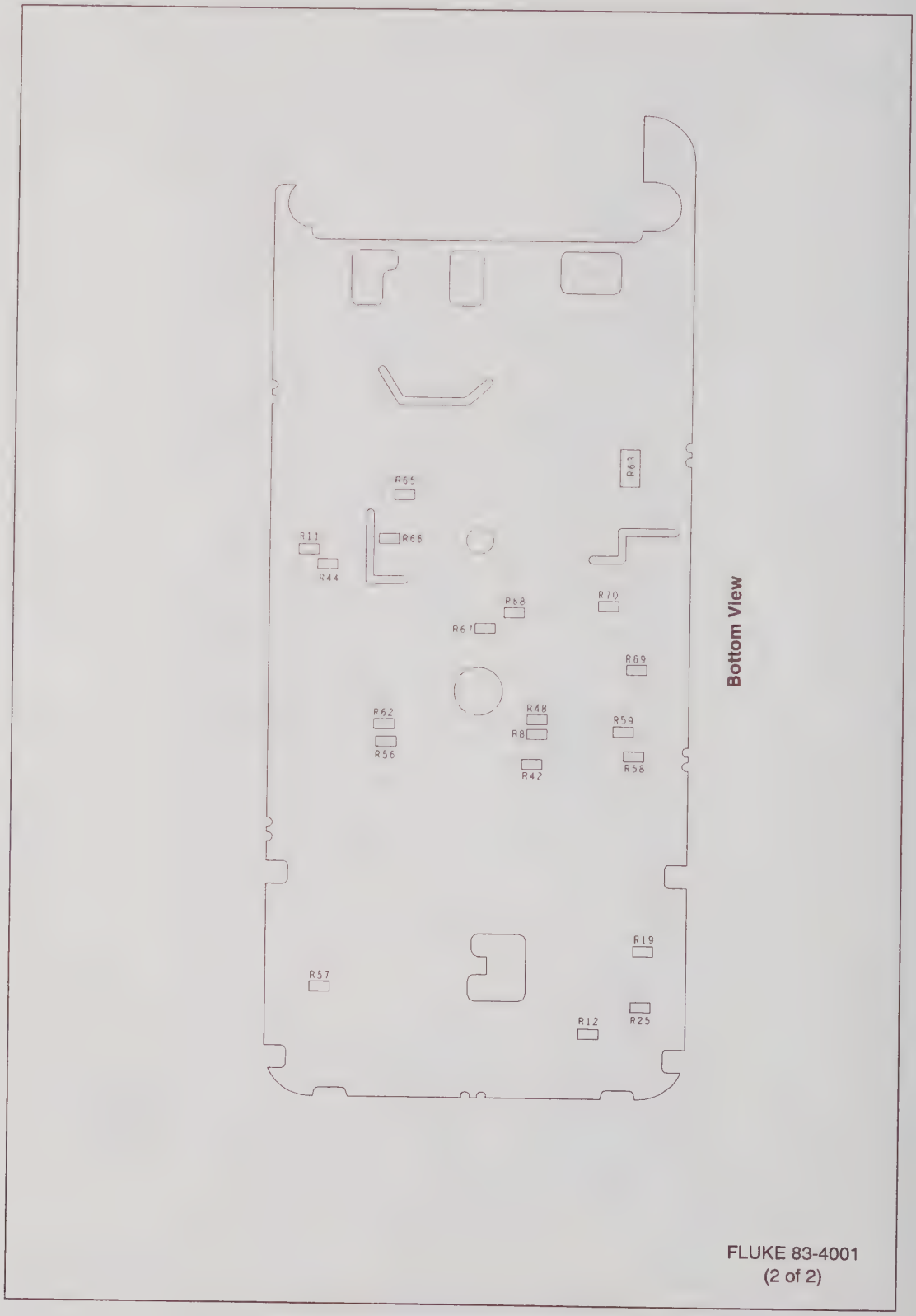

Figure 4-2. Fluke 83 A1 Main PCA (cont)

Table 4-3. Fluke 85 Final Assembly

Reference Designator	Description	Fluke Stock No	Tot Qty	Notes
A1	MAIN PCA	857867	1	
BT1	BATTERY,PRIMARY,ALKALINE,9V,0-200MA	614487	1	
E1	CONTACT,PTF	822676	1	
E2	CONTACT,ANNUNCIATOR	822791	1	
F1	FUSE,.406X1.375,0.440A,1000V,FAST	943121	1	
F2	FUSE,.406X1.5,11A,1000V,FAST	943118	1	
H1	SCREW,PH,P,THD FORM,STL,4-14,.562	832220	1	
H2	SCREW,PH,P,AM THD FORM,STL,5-14,.750	832246	3	
J1,J2	CONN,ELASTOMERIC,LCD TO PWB,1.590 L	817460	2	
MP1	MASK,LCD (PAD XFER)	930276	1	
MP2	SHIELD,TOP	824516	1	
MP3	SHAFT,SWITCH	822635	1	
MP4	SHIELD,BOTTOM, W/ BEEPER	824524	1	
MP5	CASE TOP (PAD XFER), W/WINDOW - CE	617305	1	1,3
MP6	CASE & GASKET ASSY, BOTTOM W/FUSES	617289	1	3
MP8	KNOB,SWITCH (PAD XFER)	880815	1	
MP9	SPRING,DETENT	822643	1	
MP10	FOOT,NON SKID	824466	2	
MP13	SHOCK ABSORBER	828541	1	
MP14	O-RING,NITRILE N674-70,1.670,.047	831933	1	
MP15	HOLSTER & FLEXSTAND ASSY YELLOW	822809	1	
MP19	TEST LEADS	855742	1	
MP21	INSULATOR, FUSE	203064	1	
S1	SWITCH PAD, MOMENTARY	809988	1	
TM1	FLUKE 83/85/87 SERVICE MANUAL	617826	0	2
TM5	FLUKE 83/85 USERS MANUAL (ENGLISH)	852426	1	
TM6	FLUKE 83/85 USERS MANUAL (INTERNATIONAL)	852434	1	
U5	LCD,4.5 DIGIT,BAR GRAPH,MULTIPLEXED	782763	1	

1. MP5 INCLUDES MP8 AND MP9.
2. AVAILABLE UPON REQUEST.
3. FOR SAFETY REASONS, DO NOT USE THE CASE TOP OR BOTTOM ON FLUKE 85 UNITS WITH PCA REVISION LEVELS BELOW "AC".

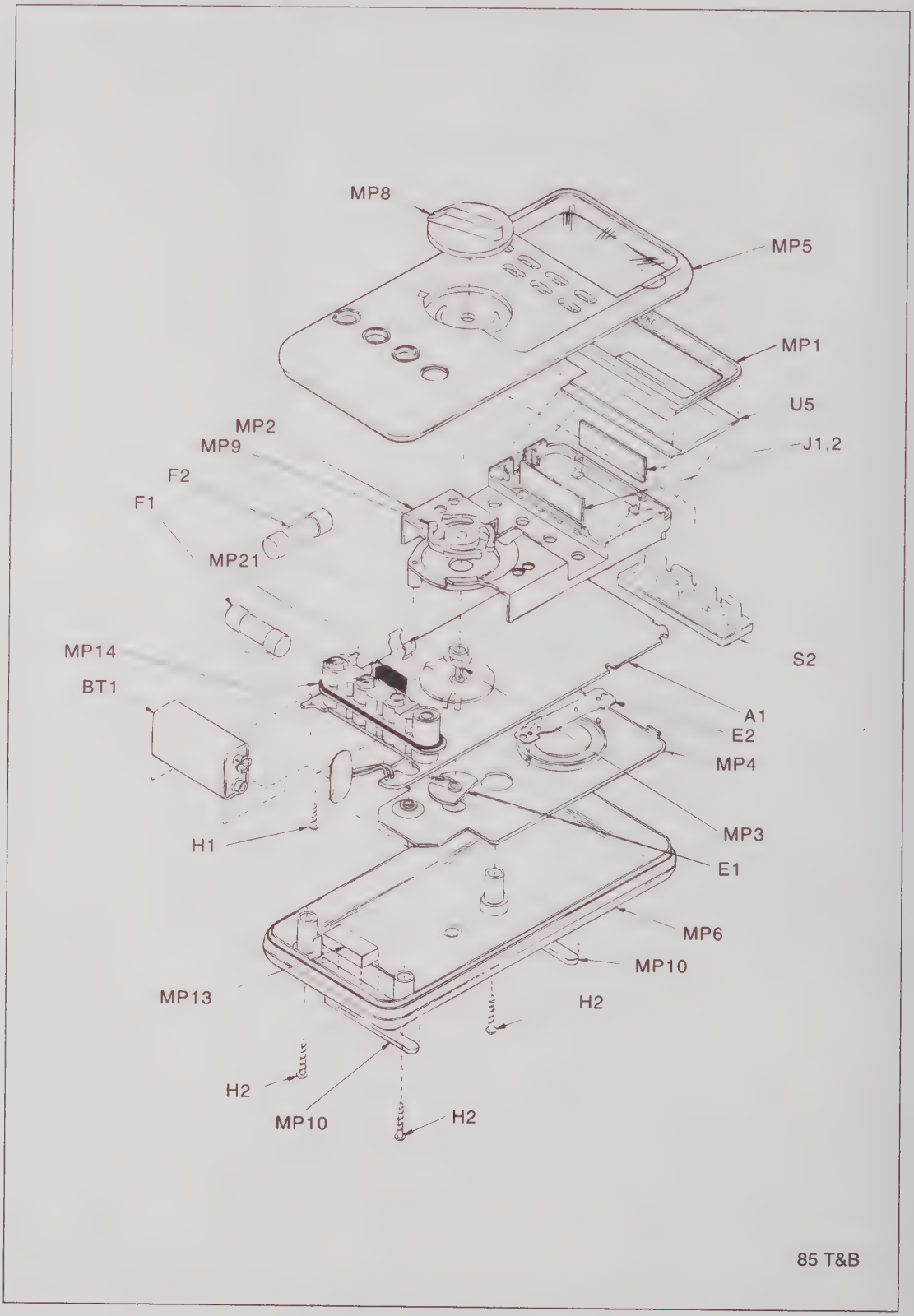

Figure 4-3. Fluke 85 Final Assembly

Table 4-4. Fluke 85 A1 Main PCA

Reference Designator		Description	Fluke Stock No	Tot Qty	Notes
C1		CAP,POLYES,0.01UF,+-10%,1000V	822361	1	
C2		CAP,VAR,3-11PF,100V,CER	641712	1	
C3		CAP,VAR,9-90PF,50V,CER	643130	1	
C4		CAP,CER,560PF,+-2%,50V,C0G,1206	943373	1	
C5		CAP,TA,15UF,+-20%,6.3V	807636	1	
C8,C9		CAP,POLYCA,0.027UF,+-10%,63V	720979	2	
C10		CAP,POLYES,0.47UF,+-10%,50V	697409	1	
C11		CAP,POLYPR,0.022UF,+-10%,63V	821579	1	
C14,C21		CAP,TA,47UF,+-20%,10V,7343	867580	2	
C15,C16,C32		CAP,CER,0.1UF,+-10%,25V,X7R,1206	747287	3	
C17,C18		CAP,CER,22PF,+-10%,50V,C0G,1206	740563	2	
C19		CAP,CER,22PF,+-10%,50V,C0G,1206	740563	1	
C20		CAP,CER,5.6PF,+-0.25PF,1500V,C0H	851811	1	
C22		CAP,CER,470PF,+-5%,50V,C0G,1206	943365	1	
C23		CAP,CER,0.01UF,+-5%,50V,C0G,1812	929364	1	
C24		CAP,TA,10UF,+-20%,10V	714766	1	
C26,C31,C33, C34		CAP,CER,0.01UF,+-10%,50V,X7R,1206	747261 747261	4	
C27		CAP,CER,120PF,+-5%,50V,C0G,1206	854141	1	
C28,C29		CAP,TA,0.47UF,+-20%,35V,3528	867259	2	
C30		CAP,CER,220PF,+-10%,50V,C0G,1206	758078	2	
C35		CAP,TA,4.7UF,+-20%,10V,3528	867262	1	
C36		CAP,CER,1000PF,+-1%,50V,C0G,1206	867668	1	
C37		CAP,VAR,0.25PF-1.5PF,1700V,TEF	910711	1	
C39		CAP,CER,150PF,+-5%,50V,C0G,080	866533	1	
CR1,CR4		DIODE,SI,1K PIV,1.0 AMP	707075	2	
CR5,CR7, CR8	*	DIODE,SI,BV=70V,IO=50MA,DUAL,SOT-23	742320 742320	3	
E1		SURGE PROTECTOR,1500V,+-20%	655134	1	
J1		INPUT RCPT ASSY	826214	1	
Q1,Q2,Q6	*	TRANSISTOR,SI,NPN,25V,0.3W,SEL	821637	3	
Q3,Q9,Q12	*	TRANSISTOR,SI,NPN,60V,350MW,SOT-23	742676	3	
Q8	*	TRANSISTOR,SI,N-DMOS FET,SOT-23	927538	1	
Q10	*	TRANSISTOR,SI,P-CHAN,SOT-23	832477	1	
Q11	*	TRANSISTOR,SI,PNP,40V,300MW,SOT-23	742684	1	
Q13,Q14	*	TRANSISTOR,SI,NPN,55V,225MW,SOT-23	912469	2	
R1		RES,WW,3.5K,+-5%,5W,20PPM	107695	1	3
R2	*	RES,CERM,909K,+-1%,2W,100PPM	831594	1	3
R3		RES,CERM,1.5K,+-5%,.125W,200PPM	746438	1	
R4		RES,MF,110.1,+-0.1%,0.125W,100PPM	821728	1	
R5		RES,WW,0.9905,+-0.1%,2.5W	821645	1	
R6		RES,WW,.010,+-.1%,1W,100PPM	807305	1	
R7,R10	*	RES,CERM,5.1M,+-5%,1W,200PPM	601796	2	
R8	*	RES,CERM,15M,+-5%,.125W,300PPM	811968	1	
R9,R13,R29	*	RES,CERM,100K,+-5%,.125W,200PPM	740548	3	
R11	*	RES,CERM,10M,+-5%,.125W,300PPM	783274	1	
R12,R65-70	*	RES,CERM,10K,+-5%,.125W,200PPM	746610	7	

Table 4-4. Fluke 85 A1 Main PCA (cont)

Reference Designator		Description	Fluke Stock No	Tot Qty	Notes
R14		RES,MF,10K,+-0.1%,0.125W,100PPM	658955	1	
R15		RES,MF,90K,+-0.1%,0.125W,100PPM	658906	1	
R17,R18,R54	*	RES,CERM,1M,+-5%,.125W,200PPM,1206	746826	3	
R19	*	RES,CERM,107K,+-1%,.125W,100PPM	875224	1	
R20	*	RES,CERM,412K,+-1%,.125W,100PPM	875229	1	
R21		RES,VAR,CERM,100K,+-20%,.3W	649897	1	
R24	*	RES,CERM,324K,+-1%,.125W,100PPM	911243	1	
R25	*	RES,CERM,210K,+-1%,.125W,100PPM	821660	1	
R30		RES,MF,20K,+-0.25%,0.125W,50PPM	715029	1	
R31,R40		RES,MF,22.6K,+-0.25%,0.125W,50PPM	715011	2	
R34	*	RES,VAR,CERM,1K,+-20%,.3W	831420	1	
R35	*	RES,CERM,665K,+-1%,.125W,100PPM	867460	1	
R37	*	RES,CERM,205K,+-1%,.125W,100PPM	769836	1	
R38	*	RES,CERM,536K,+-1%,.125W,100PPM	845420	1	
R41,R47	*	RES,CERM,0,+.05 MAX,.125W,1206	810747	2	
R42	*	RES,CERM,1M,+-5%,.125W,200PPM,1206	746826	1	
R43		RES,MF,1K,+-0.1%,0.125W,100PPM	821694	1	
R44	*	RES,CERM,82K,+-5%,.125W,200PPM	811794	1	
R46		RES JUMPER,0.02,0.25W	682575	1	
R48	*	RES,CERM,5.1M,+-5%,.125W,300PPM	876490	1	
R56,R57	*	RES,CERM,22K,+-5%,.125W,200PPM	746651	2	
R58	*	RES,CERM,120K,+-5%,.125W,200PPM	746719	1	
R59	*	RES,CERM,510,+-5%,.125W,200PPM	746388	1	
R62	*	RES,CERM,100K,+-5%,.125W,200PPM	740548	1	
R63	*	RES,CERM,1K,+-5%,1W,200PPM,251PPM	601176	1	
R64	*	RES,CERM,10K,+-5%,.125W,200PPM	746610	1	
RT1		THERMISTOR,RECT,POS,1.5K,+-30%	822015	1	3
RV1,RV2		VARISTOR,910,+-10%,1.0MA	876193	2	3
S1		SWITCH,ROTARY	819334	1	
U1		DIODE,SI,RECT,BRIDGE,BV=50V,IO=1A	418582	1	
U4		SMX2 OLY 85 IC	921601	1	
U6	*	IC,CMOS,HEX INVERTER,SOIC	838375	1	
VR1	*	IC,1.23V,60PPM TC,BAND-GAP REF	654707	1	
W1		JUMPER WIRE NEG	834994	1	
W2		JUMPER WIRE,POS	835009	1	
W3		WIRE, JUMPER	203067	1	
XBT1		CONNECTOR,BATTERY	825976	1	
XF1		FUSE CONTACT	659524	2	1
XF2		FUSE CONTACT	707190	2	2
Y1		CRYSTAL,131.072KHZ,0.003%,3X8MM	831453	1	
Z1		RNET,MF,POLY,SIP,FLUKE85 HI V DIVIDER	915871	1	

1. REF.DES XF1 IS TWO (2) PARTS. THEY ARE USED WITH F1 ON THE FINAL ASSEMBLY.
2. REF.DES XF2 IS TWO (2) PARTS. THEY ARE USED WITH F2 ON THE FINAL ASSEMBLY.
3. TO ENSURE SAFETY, USE EXACT REPLACEMENT ONLY.

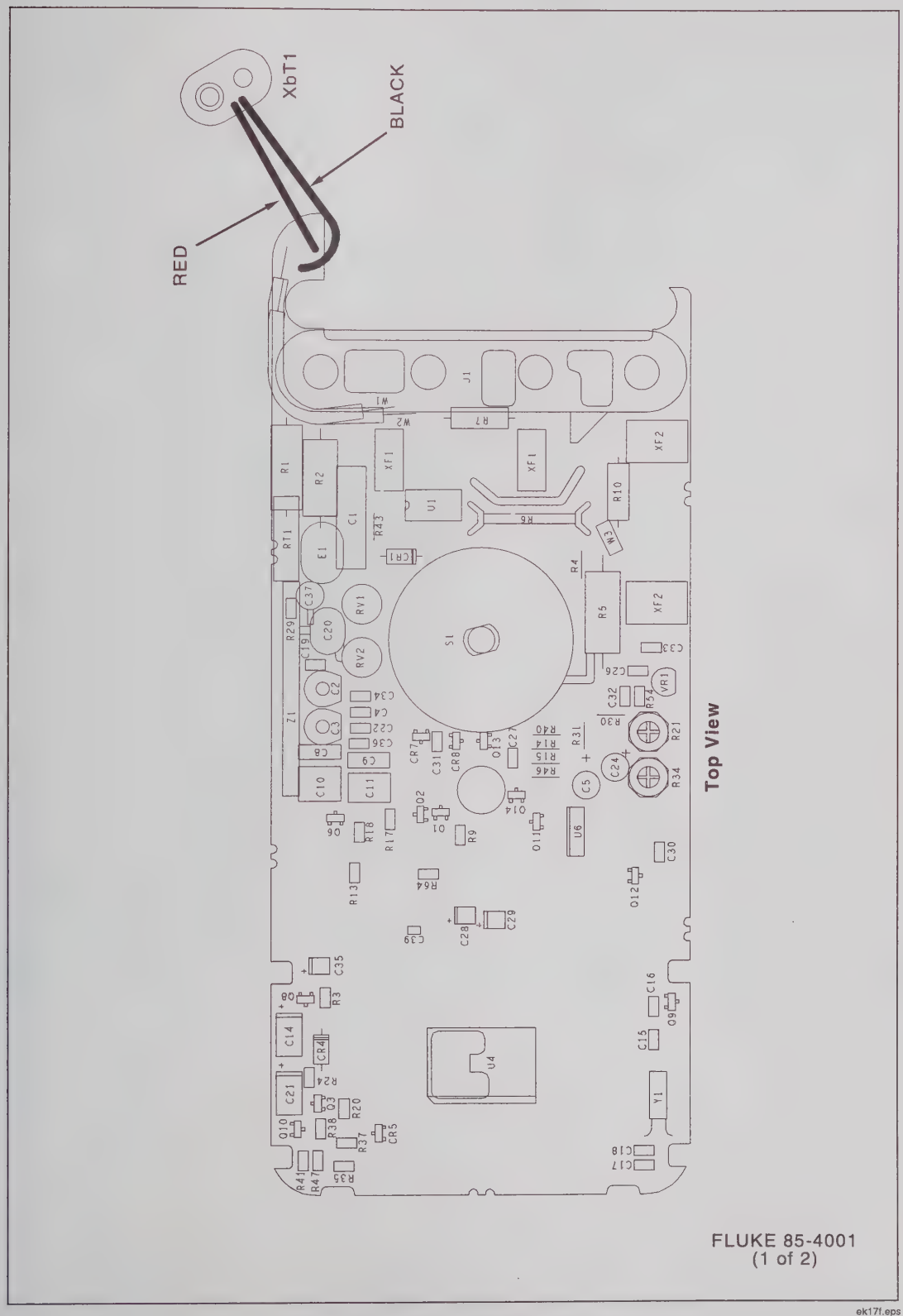

Figure 4-4. Fluke 85 A1 Main PCA

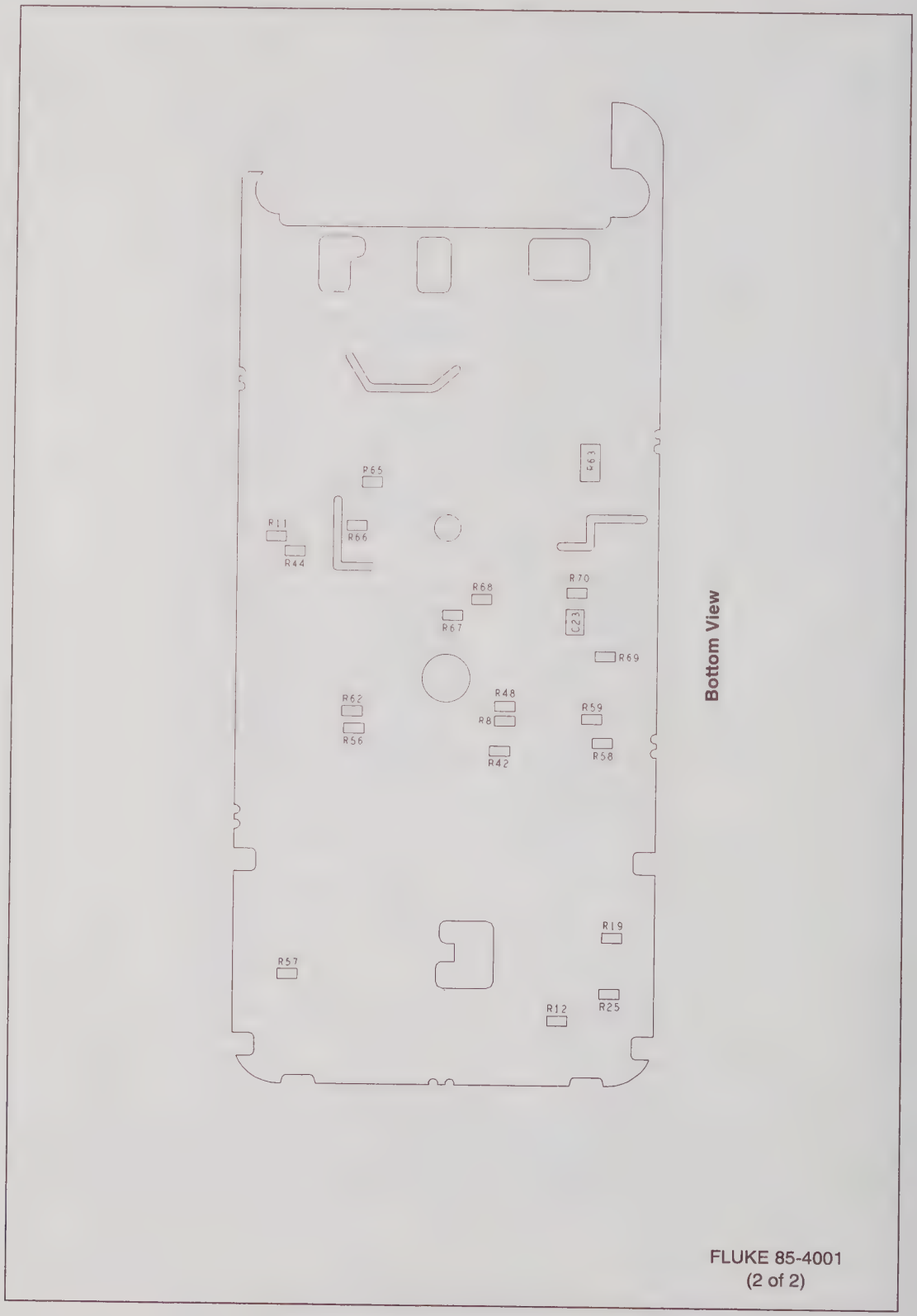

Figure 4-4. Fluke 85 A1 Main PCA (cont)

Table 4-5. Fluke 87 Final Assembly

Reference Designator	Description	Fluke Stock No	Tot Qty	Notes
A1	MAIN PCA	857862	1	
BT1	BATTERY,PRIMARY,ALKALINE,9V,0-200MA	614487	1	
CR6	BACKLIGHT	819342	1	
E1	CONTACT,PTF	822676	1	
E2	CONTACT,ANNUNCIATOR	822791	1	
F1	FUSE,.406X1.375,0.440A,1000V,FAST	943121	1	
F2	FUSE,.406X1.5,11A,1000V,FAST	943118	1	
H1	SCREW,PH,P,THD FORM,STL,4-14,.562	832220	1	
H2	SCREW,PH,P,AM THD FORM,STL,5-14,.750	832246	3	
J1,J2	CONN,ELASTOMERIC,LCD TO PWB,1.590 L	817460	2	
MP1	MASK,LCD (PAD XFER)	930271	1	
MP2	SHIELD,TOP	824516	1	
MP3	SHAFT,SWITCH	822635	1	
MP4	SHIELD,BOTTOM, W/ BEEPER	824524	1	
MP5	CASE TOP (PAD XFER), W/WINDOW - CE	617313	1	1,3
MP6	CASE & GASKET ASSY, BOTTOM W/FUSES	200573	1	3
MP8	KNOB,SWITCH (PAD XFER)	880815	1	
MP9	SPRING,DETENT	822643	1	
MP10	FOOT,NON SKID	824466	2	
MP13	SHOCK ABSORBER	828541	1	
MP14	O-RING,NITRILE N674-70,1.670,.047	831933	1	
MP15	HOLSTER & FLEXSTAND ASSY YELLOW	822809	1	
MP19	TEST LEADS	855742	1	
MP21	INSULATOR, FUSE	203064	1	
S1	SWITCH PAD, MOMENTARY	809970	1	
TM1	FLUKE 83/85/87 SERVICE MANUAL	617826	0	2
TM5	FLUKE 87 USERS MANUAL (ENGLISH)	852418	1	
TM6	FLUKE 87 USERS MANUAL (INTERNATIONAL)	852421	1	
U5	LCD,4.5 DIGIT,BAR GRAPH,MULTIPLEXED	832188	1	

1. MP5 INCLUDES MP8 AND MP9.
2. AVAILABLE UPON REQUEST.
3. FOR SAFETY REASONS, DO NOT USE THE CASE TOP OR BOTTOM ON FLUKE 87 UNITS WITH PCA REVISION LEVELS BELOW "AG".

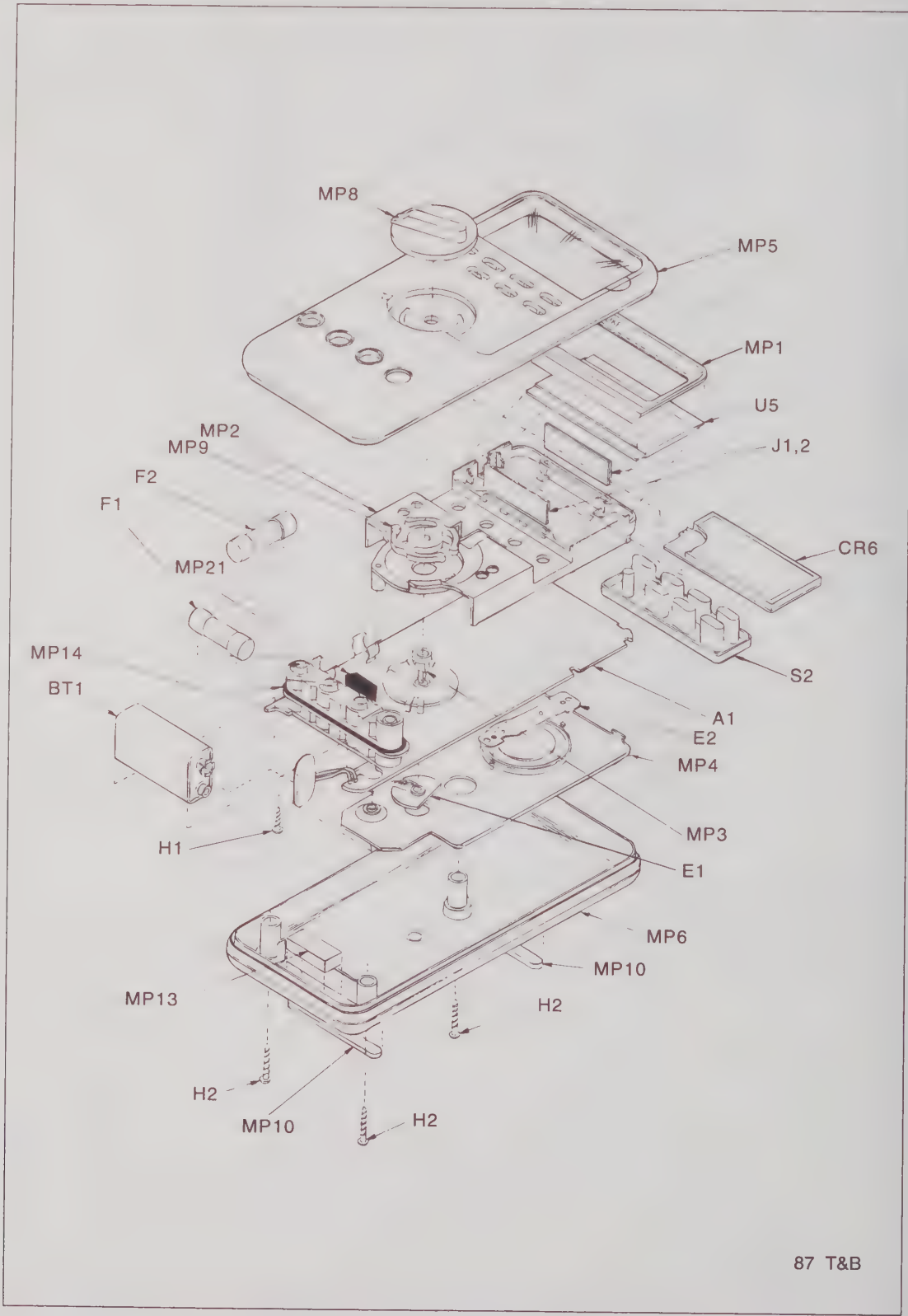

Figure 4-5. Fluke 87 Final Assembly

Table 4-6. Fluke 87 A1 Main PCA

Reference Designator		Description	Fluke Stock No	Tot Qty	Notes
AR1		IC,OP AMP,DUAL,FIX MED POWER,SOIC	830810	1	
C1		CAP,POLYES,0.01UF,+-10%,1000V	822361	1	
C2		CAP,VAR,3-11PF,100V,CER	641712	1	
C3		CAP,VAR,9-90PF,50V,CER	643130	1	
C4		CAP,CER,560PF,+-2%,50V,C0G,1206	943373	1	
C5		CAP,TA,15UF,+-20%,6.3V	807636	1	
C6		CAP,TA,22UF,+-20%,10V	658971	1	
C7		CAP,TA,10UF,+-20%,10V	714766	1	
C8,C9		CAP,POLYCA,0.027UF,+-10%,63V	720979	2	
C10		CAP,POLYES,0.47UF,+-10%,50V	697409	1	
C11		CAP,POLYPR,0.022UF,+-10%,63V	821579	1	
C12,C13		CAP,POLYPR,0.068UF,+-20%,100V	852132	2	
C14,C21		CAP,TA,47UF,+-20%,10V,7343	867580	2	
C15,C16,C32		CAP,CER,0.1UF,+-10%,25V,X7R,1206	747287	3	
C17,C18		CAP,CER,22PF,+-10%,50V,C0G,1206	740563	2	
C19		CAP,CER,22PF,+-10%,50V,C0G,1206	740563	1	
C20		CAP,CER,5.6PF,+-0.25PF,1500V,C0H	851811	1	
C22		CAP,CER,470PF,+-5%,50V,C0G,1206	943365	1	
C23		CAP,CER,0.01UF,+-5%,50V,C0G,1812	929364	1	
C26,C31,C33,		CAP,CER,0.01UF,+-10%,50V,X7R,1206	747261	4	
C34			747261		
C27		CAP,CER,82PF,+-5%,50V,C0G,1206	740555	1	
C30		CAP,CER,220PF,+-10%,50V,C0G,1206	758078	1	
C35		CAP,TA,4.7UF,+-20%,10V,3528	867262	1	
C36		CAP,CER,1000PF,+-1%,50V,C0G,1206	867668	1	
C37		CAP,VAR,0.25PF-1.5PF,1700V,TEFLON	910711	1	
CR1,CR4		DIODE,SI,1K PIV,1.0 AMP	707075	2	
CR2,CR3	*	DIODE,SI,BV=20V,IO=50MA,250MW	836288	2	
CR5,CR7,	*	DIODE,SI,BV=70V,IO=50MA,DUAL,SOT-23	742320	3	
CR8			742320		
E1		SURGE PROTECTOR,1500V,+-20%	655134	1	
J1		INPUT RCPT ASSY	826214	1	
J2		SOCKET,1 ROW,PWB,0.100CTR,2 POS	832634	1	
Q1,Q2,Q6	*	TRANSISTOR,SI,NPN,25V,0.3W,SEL,SOT-23	821637	3	
Q3,Q4,Q7,	*	TRANSISTOR,SI,NPN,60V,350MW,SOT-23	742676	5	
Q9,Q12	*		742676		
Q5,Q11	*	TRANSISTOR,SI,PNP,40V,300MW,SOT-23	742684	2	
Q8	*	TRANSISTOR,SI,N-DMOS FET,SOT-22	927538	1	
Q10	*	TRANSISTOR,SI,P-CHAN,SOT-23	832477	1	
Q13,Q14	*	TRANSISTOR,SI,NPN,55V,225MW,SOT-23	912469	2	
R1		RES,WW,3.5K,+-5%,5W,20PPM	107695	1	3
R2	*	RES,CERM,909K,+-1%,2W,100PPM	831594	1	3
R3	*	RES,CERM,1.5K,+-5%,.125W,200PPM	746438	1	
R4		RES,MF,110.1,+-0.1%,0.125W,100PPM	821728	1	
R5		RES,WW,0.9905,+-0.1%,2.5W	821645	1	
R6		RES,WW,.010,+-.1%,1W,100PPM	807305	1	
R7,R10	*	RES,CERM,5.1M,+-5%,1W,200PPM	601796	2	
R8	*	RES,CERM,15M,+-5%,.125W,300PPM	811968	1	
R9,R13,R29,	*	RES,CERM,100K,+-5%,.125W,200PPM	740548	4	
R53	*		740548		

Table 4-6. Fluke 87 A1 Main PCA (cont)

Reference Designator		Description	Fluke Stock No	Tot Qty	Notes
R11	*	RES,CERM,10M,+-5%,.125W,300PPM	783274	1	
R12,R65-70	*	RES,CERM,10K,+-5%,.125W,200PPM	746610	7	
R14		RES,MF,10K,+-0.1%,0.125W,100PPM	658955	1	
R15		RES,MF,40K,+-0.1%,0.125W,100PPM	821702	1	
R17,R18,R54	*	RES,CERM,1M,+-5%,.125W,200PPM,1206	746826	3	
R19	*	RES,CERM,107K,+-1%,.125W,100PPM	875224	1	
R20	*	RES,CERM,412K,+-1%,.125W,100PPM	875229	1	
R21		RES,VAR,CERM,100K,+-20%,.3W	649897	1	
R22,R23	*	RES,CERM,2K,+-5%,.125W,200PPM,1206	746461	2	
R24	*	RES,CERM,324K,+-1%,.125W,100PPM	911243	1	
R25	*	RES,CERM,210K,+-1%,.125W,100PPM	821660	1	
R31		RES JUMPER,0.02,0.25W	682575	1	
R32	*	RES,CERM,75K,+-5%,.125W,200PPM	811901	1	
R34	*	RES,VAR,CERM,200,+-20%,.3W	867965	1	
R35	*	RES,CERM,665K,+-1%,.125W,100PPM	867460	1	
R37	*	RES,CERM,205K,+-1%,.125W,100PPM	769836	1	
R38	*	RES,CERM,536K,+-1%,.125W,100PPM	845420	1	
R39	*	RES,CERM,56K,+-5%,.125W,200PPM	746701	1	
R42	*	RES,CERM,1M,+-5%,.125W,200PPM,1206	746826	1	
R44	*	RES,CERM,82K,+-5%,.125W,200PPM	811794	1	
R43		RES,MF,1K,+-0.1%,0.125W,100PPM	821694	1	
R45,R50	*	RES,CERM,0,+.05 MAX,.125W,1206	810747	2	
R46		RES,MF,50K,+-0.1%,0.125W,100PPM	821710	1	
R48	*	RES,CERM,5.1M,+-5%,.125W,300PPM	876490	1	
R56,R57	*	RES,CERM,22K,+-5%,.125W,200PPM	746651	2	
R58	*	RES,CERM,120K,+-5%,.125W,200PPM	746719	1	
R59	*	RES,CERM,510,+-5%,.125W,200PPM	746388	1	
R61	*	RES,CERM,2.2M,+-5%,.125W,200PPM	811778	1	
R62	*	RES,CERM,100K,+-5%,.125W,200PPM	740548	1	
R63	*	RES,CERM,1K,+-5%,1W,200PPM,251PPM	601176	1	
RT1		THERMISTOR,RECT,POS,1.5K,+-30%	822015	1	3
RV1,RV2		VARISTOR,910,+-10%,1.0MA	876193	2	3
S1		SWITCH,ROTARY	819334	1	
U1		DIODE,SI,RECT,BRIDGE,BV=50V,IO=1A	418582	1	
U2	*	IC,BPLR,TRUE RMS TO DC CONVERT,SOIC	868000	1	
U4		SMX2 OLY 87 IC	921606	1	
U6	*	IC,CMOS,HEX INVERTER,SOIC	838375	1	
VR1	*	IC,1.23V,60PPM TC,BAND-GAP REF	654707	1	
W1		JUMPER WIRE NEG	834994	1	
W2		JUMPER WIRE,POS	835009	1	
W3		WIRE, JUMPER	203067	1	
XBT1		CONNECTOR,BATTERY	825976	1	
XF1		FUSE CONTACT	659524	2	
XF2		FUSE CONTACT	707190	2	
Y1		CRYSTAL,131.072KHZ,0.003%,3X8MM	831453	1	
Z1		RNET,MF,POLY,SIP,FLUKE85 HI V DIVIDER	915871	1	

1. REF.DES XF1 IS TWO (2) PARTS. THEY ARE USED WITH F1 ON THE FINAL ASSEMBLY.
2. REF.DES XF2 IS TWO (2) PARTS. THEY ARE USED WITH F2 ON THE FINAL ASSEMBLY.
3. TO ENSURE SAFETY, USE EXACT REPLACEMENT ONLY.

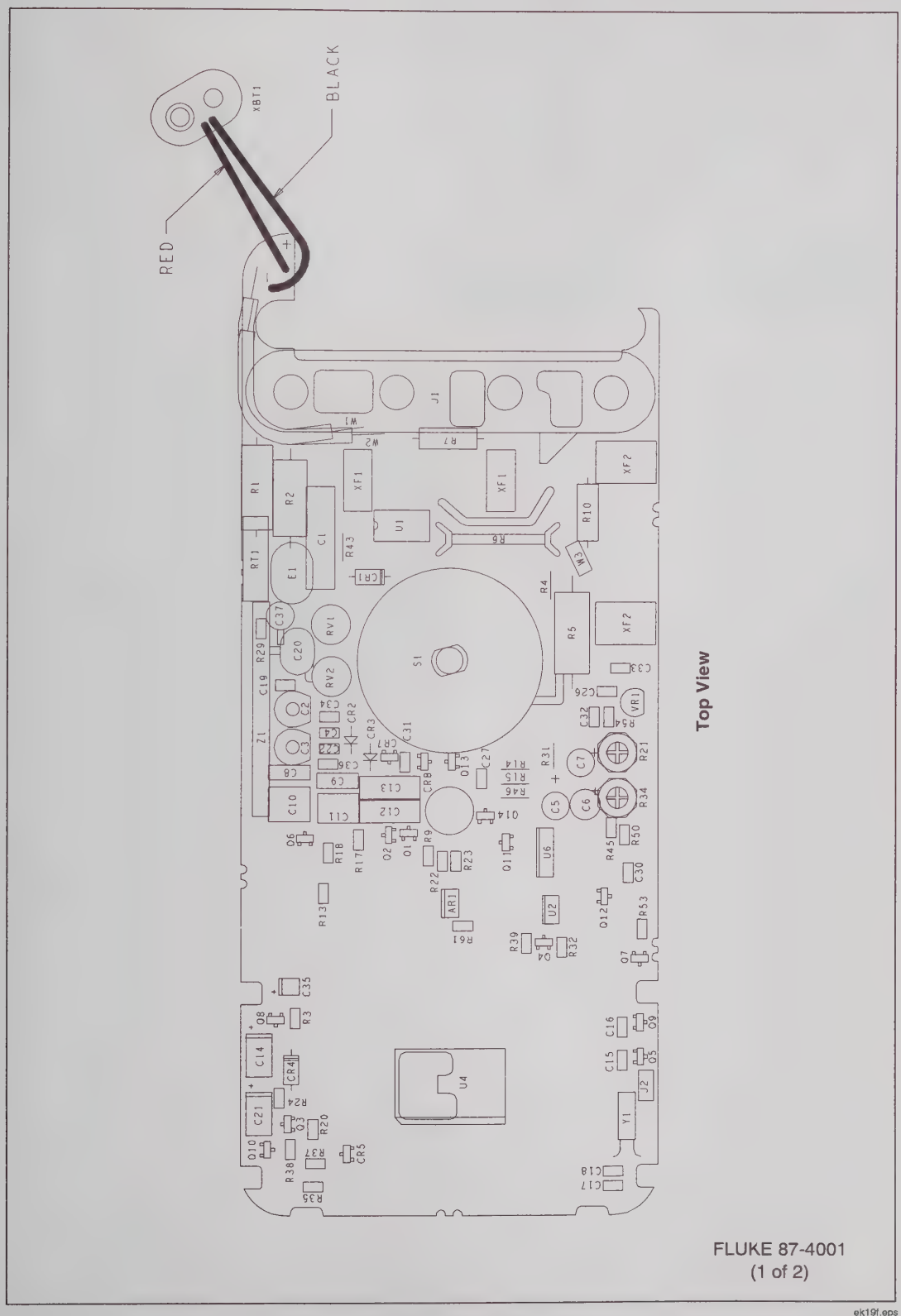

Figure 4-6. Fluke 87 A1 Main PCA

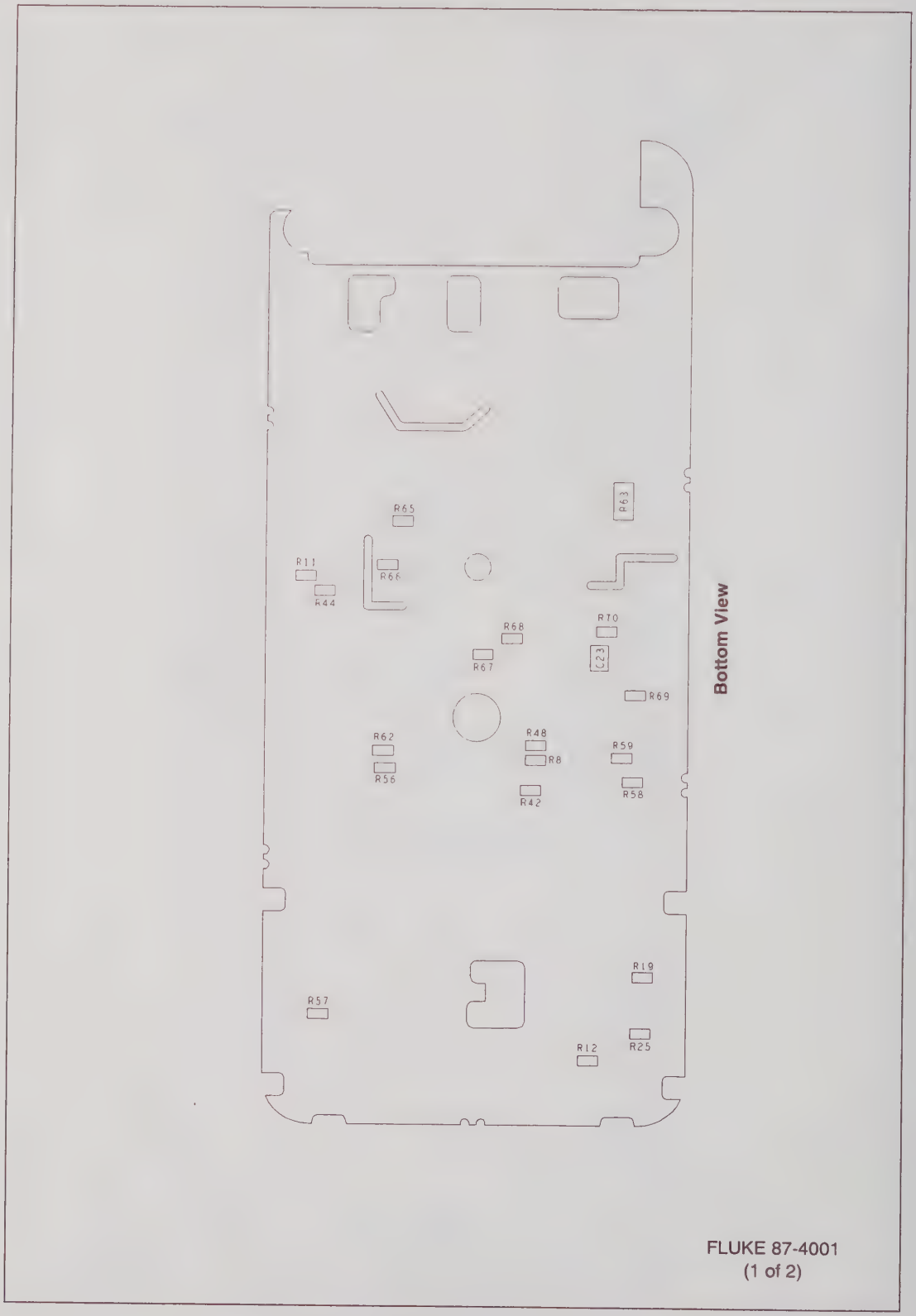

Figure 4-6. Fluke 87 A1 Main PCA (cont)

Chapter 5
Schematic Diagrams

Figure	Title	Page
5-1.	Fluke 83 A1 Main PCA	5-4
5-2.	Fluke 85 A1 Main PCA	5-8
5-3.	Fluke 87 A1 Main PCA	5-12

Table 5-1. Signal Abbreviations

ACBM	AC Buffer Minus (inverting input)	INT	Integrator output
ACBO	AC Buffer Output	K0	Buffer output times .874
AFI	Active Filter Input	K1	Buffer output times 1
AFO	Active Filter Output	K2	Buffer output times 10
AGND	Analog Ground	PDS	Power Down (off) Signal
AP0	Analog Port 0 (guard)	P00	Port 00 (keypad)
AP1	Analog Port 1 (ohms, millivolts sense)	P01	Port 01 (keypad)
AP2	Analog Port 2 (ohms reference sense)	P02	Port 02 (keypad)
AP3	Analog Port 3 (amps sense)	P03	Port 03 (PTF reference and position change sense)
AP4	Analog Port 4 (milli/micro amps jack sense)	P10	Port 10 (keypad)
AP5	Analog Port 5 (amps jack sense)	P11	Port 11 (keypad)
AP6	Analog Port 6 (PTF position sense)	P12	Port 12 (keypad)
AP7	Analog Port 7 (peak hold min sense)	P13	Port 13 (PW2, RMS power down drive)
AP8	Analog Port 8 (peak hold max sense)	PS0	Power Supply 0 (feed back for VDD regulator)
APV0	Analog Port Voltage 0 (divider input)	PS1	Power Supply 1 (feed back for common regulator)
APV1	Analog Port Voltage 1 (divide by 10)	PS2	Power Supply 2 (output for common regulator)
APV2	Analog Port Voltage 2 (divide by 100)	PW2	Power 2 (power down drive for RMS converter)
APV3	Analog Port Voltage 3 (divide by 1000)	REFH	Reference High (1.23V)
APV4	Analog Port Voltage 4 (divide by 10000)	REFI	Reference In (1.00V)
APCC	Analog Port Compensation Capacitor	RESET	Reset for µP
AVAM	Absolute Value Amplifier Minus (inverting input)	S0	LCD Segment drive 0
AVAOM	Absolute Value Amplifier Output Minus	•	
AVAOP	Absolute Value Amplifier Output Positive	•	
AZ	Auto Zero	•	
CK1	Clock 1 (RC clock output)	S31	LCD Segment drive 31
CK2	Clock 2 (RC clock input)	TEST	Factory Test
COM	Common	VBT+	Plus battery voltage
FAI	Filter Active Input	VBT -	Minus battery voltage
FAO	Filter Active Output	VDD	Plus system supply
H1	LCD backplane drive 1	VDGND	Digital Ground
H2	LCD backplane drive 2	VOA	2/3 voltage for LCD drive
H3	LCD backplane drive 3	VOB	1/3 voltage for LCD drive
H4	LCD backplane drive 4	VSS	Minus system supply

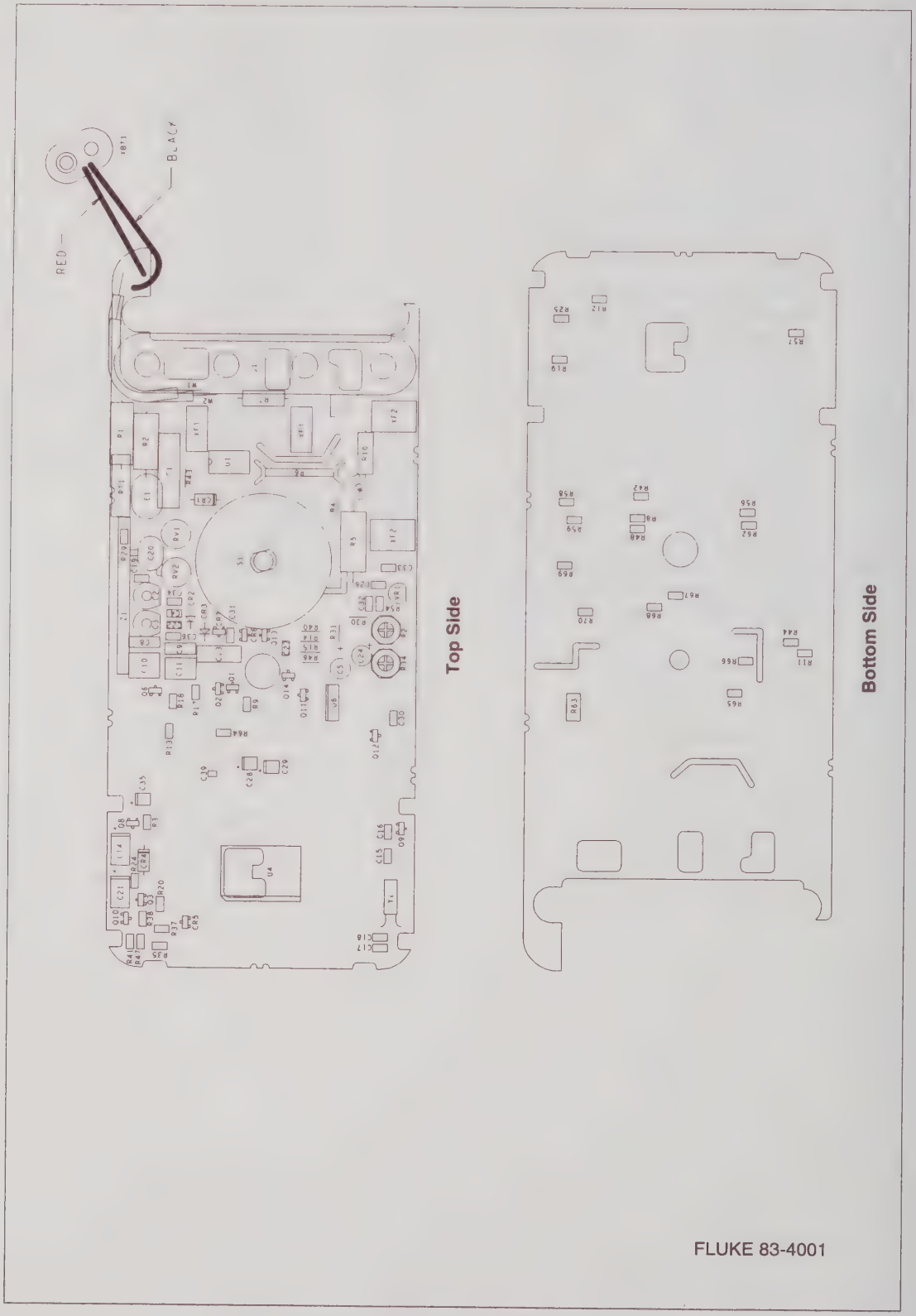

Figure 5-1. Fluke 83 A1 Main PCA

NOTES: UNLESS OTHERWISE SPECIFIED.

1. ALL CAPACITANCE VALUES ARE IN MICROFARADS. TANTALUMS ARE +/-20%. ALL OTHERS ARE +/-10%

2. ALL RESISTANCE VALUES ARE IN OHMS, 1/8 WATT,+/- 5%,CERMET. +/-.25% & +/-1% RESISTORS ARE 1/8 WATT.

REFERENCE DESIGNATION			
LAST	USED		NOT USED
AR		AR	1
BT	1	BT	
C	39	C	6,7,12,13,23, 25,37,38,40
CR	8	CR	2,3,6
E	2	E	
F	2	F	
J	1	J	
LS	1	LS	
Q	14	Q	4,5,7
R	70	R	16,22,23,26,27 28,32,33,36,39 45,49,50,51,52 53,60
RT	1	RT	
RV	2	RV	
S	9	S	
TP	7	TP	
U	6	U	2,3
VR	1	VR	
Y	1	Y	
Z	1	Z	
W	3		

COMPONENT TYPE ABBREVIATION CODE			
SYM	CAPACITOR	SYM	RESISTOR
M	MYLAR/POLYESTER	MG	METAL GLAZE
C	CERAMIC	WW	WIRE WOUND
T	TANTALUM	MF	METAL FILM
PC	POLYCARBONATE		
PP	POLYPROPYLENE		

ROTARY SWITCH INFORMATION			
POSITION	FRONT	REAR	TEST ROTARY SWITCH** +/-12 COUNTS
OFF		1 2*	
ACV		1-2	0
DCV	3-4	1-2	32
mVDC	3-4 11-12		64
Ω	3-4-5 11-12		96
→|←	4-6 11-12	1 2	128
mA/A		9-8 1-2*	160
uA	3 4*	10 9	192

*CONNECTION NOT USED FOR OPERATION
**POWER UP OPTION
PRESS RANGE BUTTON DOWN FOR 2 SECS WHILE TURNING ON METER

FLUKE 83-1201
(1 OF 3)

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Figure 5-1. Fluke 83 A1 Main PCA (cont)

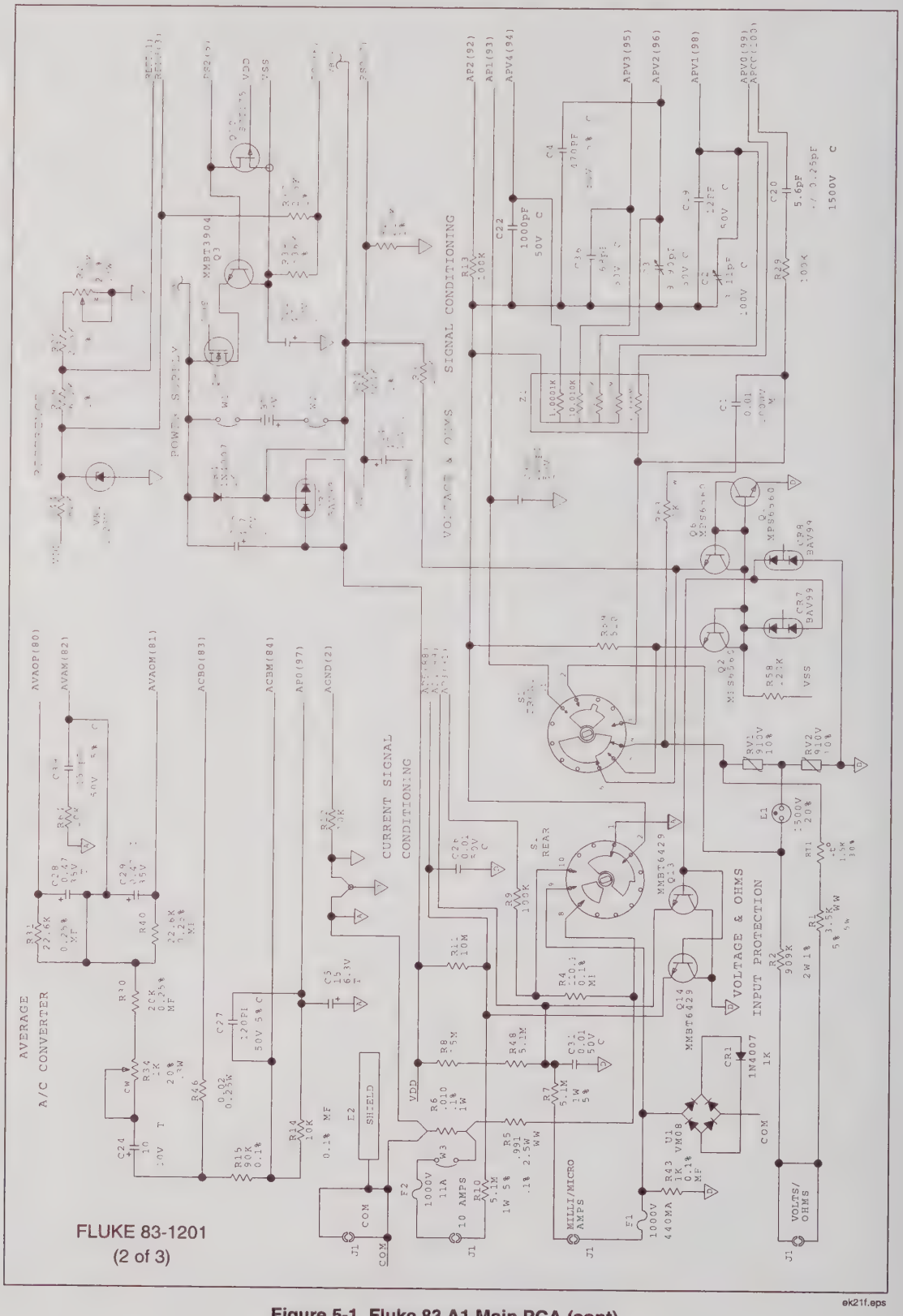


Figure 5-1. Fluke 83 A1 Main PCA (cont)

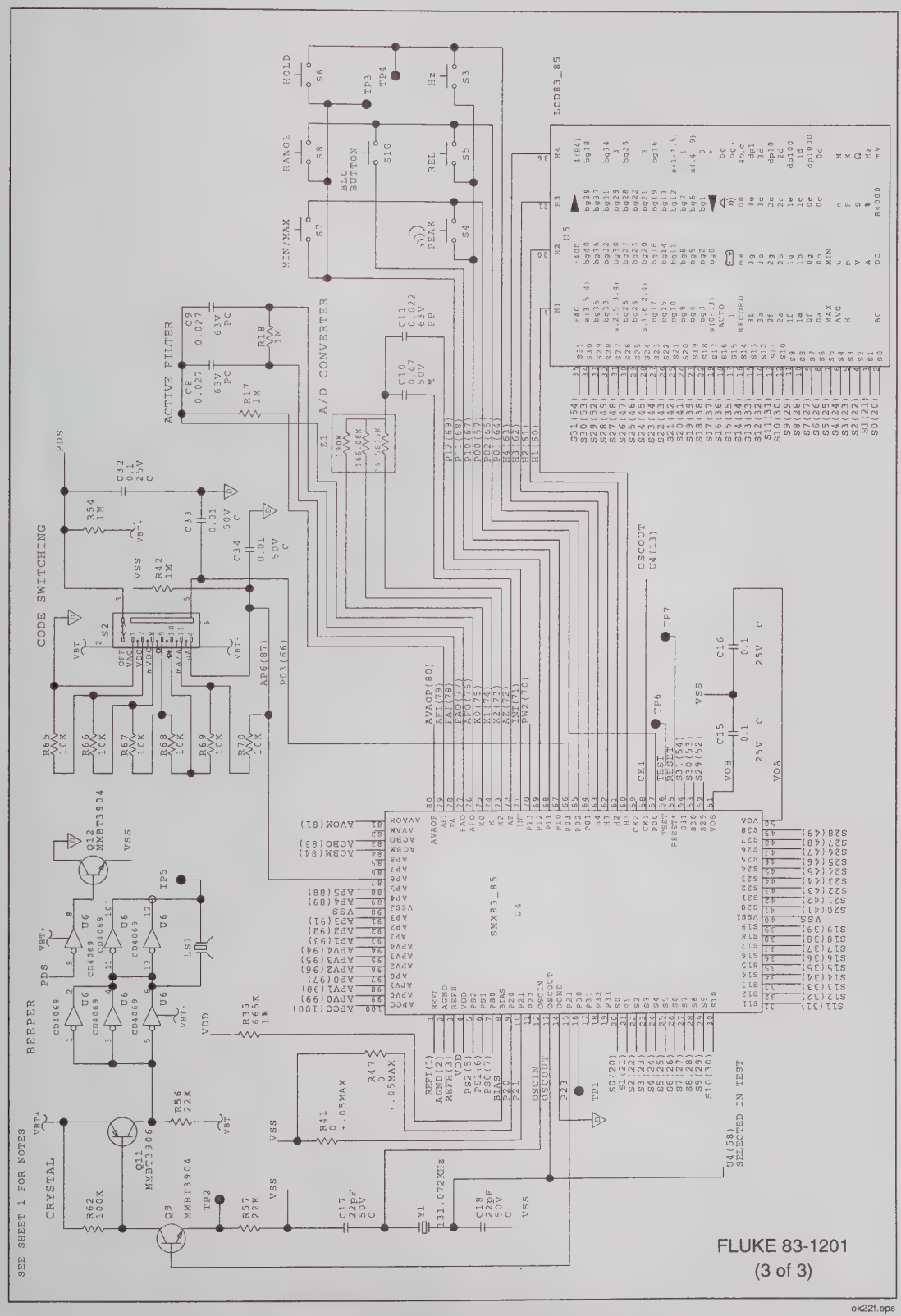
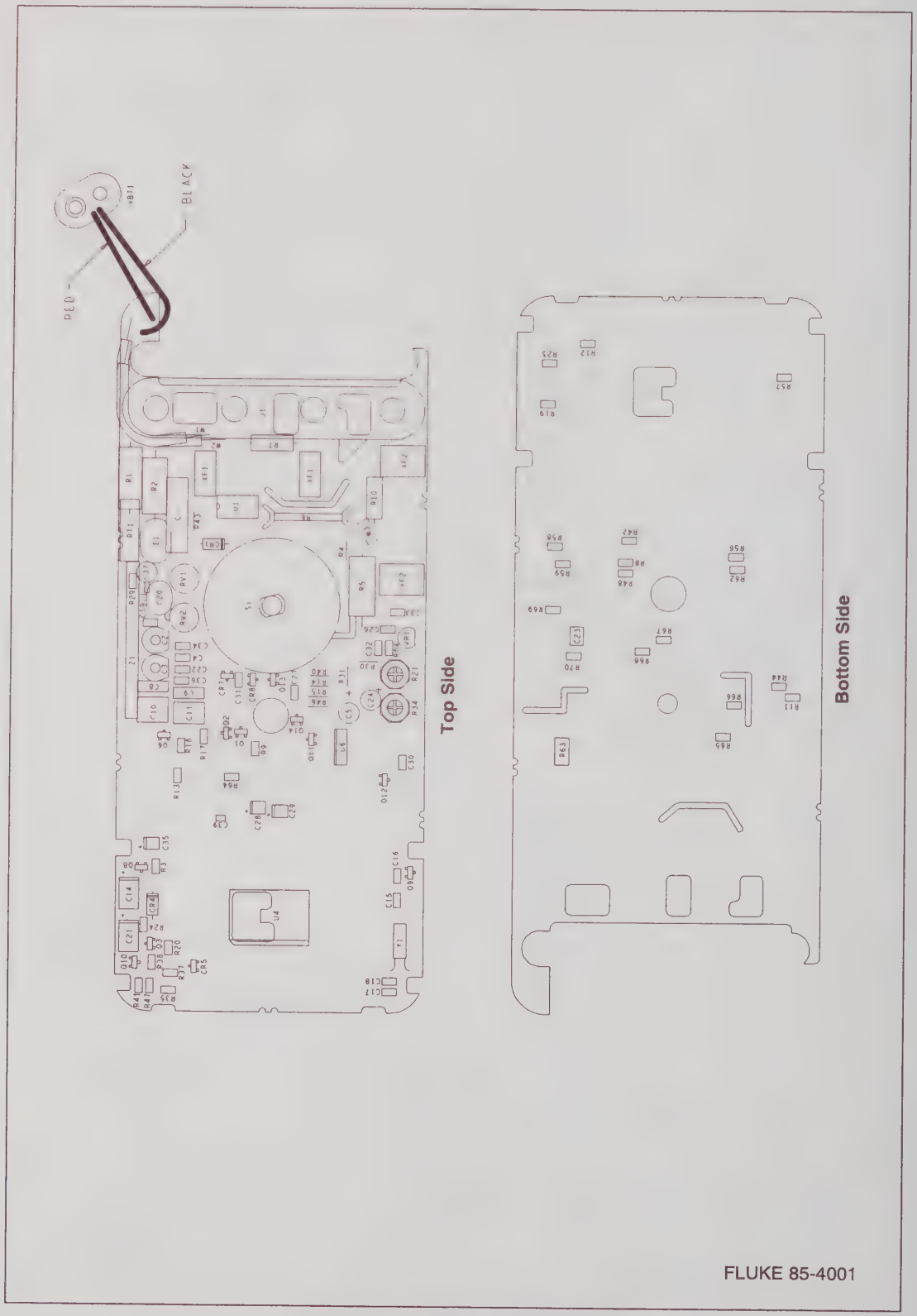


Figure 5-1. Fluke 83 A1 Main PCA (cont)



ek23f.eps

Figure 5-2. Fluke 85 A1 Main PCA

NOTES: UNLESS OTHERWISE SPECIFIED.

1. ALL CAPACITANCE VALUES ARE IN MICROFARADS. TANTALUMS ARE +/-20%. ALL OTHERS ARE +/-10%

2. ALL RESISTANCE VALUES ARE IN OHMS, 1/8 WATT,+/- 5%,CERMET. +/-.25% & +/-1% RESISTORS ARE 1/8 WATT.

ROTARY SWITCH INFORMATION			
POSITION	FRONT	REAR	TEST ROTARY SWITCH** +/-12 COUNTS
OFF		1-2*	
ACV		1-2	0
DCV	3-4	1-2	32
mVDC	3-4 11 12		64
Ω	3-4-5		96
—▶—	4-6 11-12	1-2	128
mA/A		9-8 1-2*	160
uA	3-4*	10-9	192

*CONNECTION NOT USED FOR OPERATION
**POWER UP OPTION
PRESS RANGE BUTTON DOWN FOR 2 SECS WHILE TURNING ON METER

COMPONENT TYPE ABBREVIATION CODE			
SYM	CAPACITOR	SYM	RESISTOR
M	MYLAR/POLYESTER	MG	METAL GLAZE
C	CERAMIC	WW	WIRE WOUND
T	TANTALUM	MF	METAL FILM
PC	POLYCARBONATE		
PP	POLYPROPYLENE		

REFERENCE DESIGNATION			
LAST	USED		NOT USED
AR		AR	1
BT	1	BT	
C	39	C	6,7,12,13,25, 38,40
CR	8	CR	2,3,4,6
E	2	E	
F	2	F	
J	1	J	
LS	1	LS	
Q	14	Q	
R	70	R	16,22,23,26,27 28,32,33,36,39 45,49,50,51,52 53,55,60
RT	1	RT	
RV	2	RV	
S	9	S	
TP	7	TP	
U	6	U	2,3
VR	1	VR	
Y	1	Y	
Z	1	Z	
W	3		

FLUKE 85-1201
(1 OF 3)

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Figure 5-2. Fluke 85 A1 Main PCA (cont)

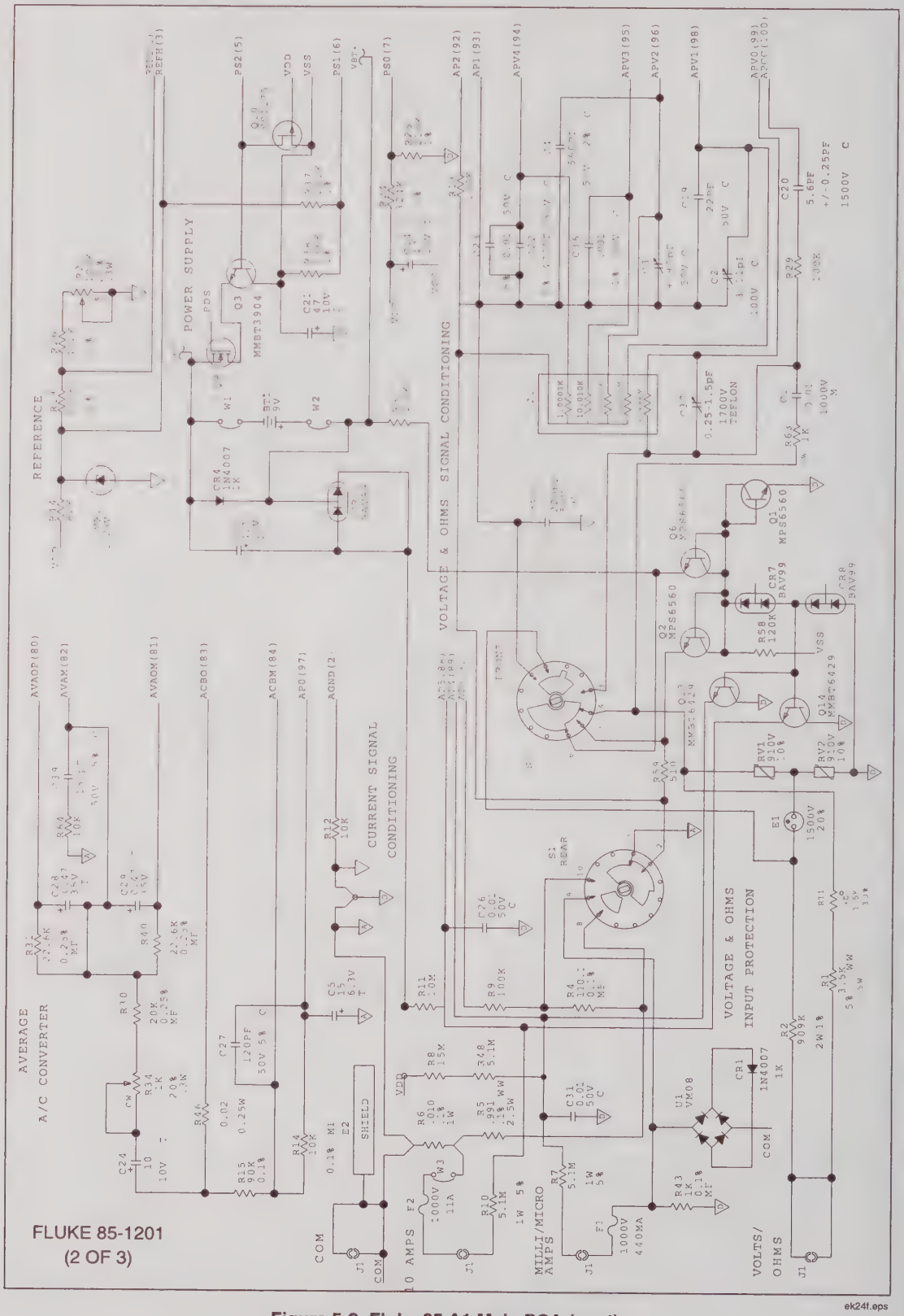

Figure 5-2. Fluke 85 A1 Main PCA (cont)

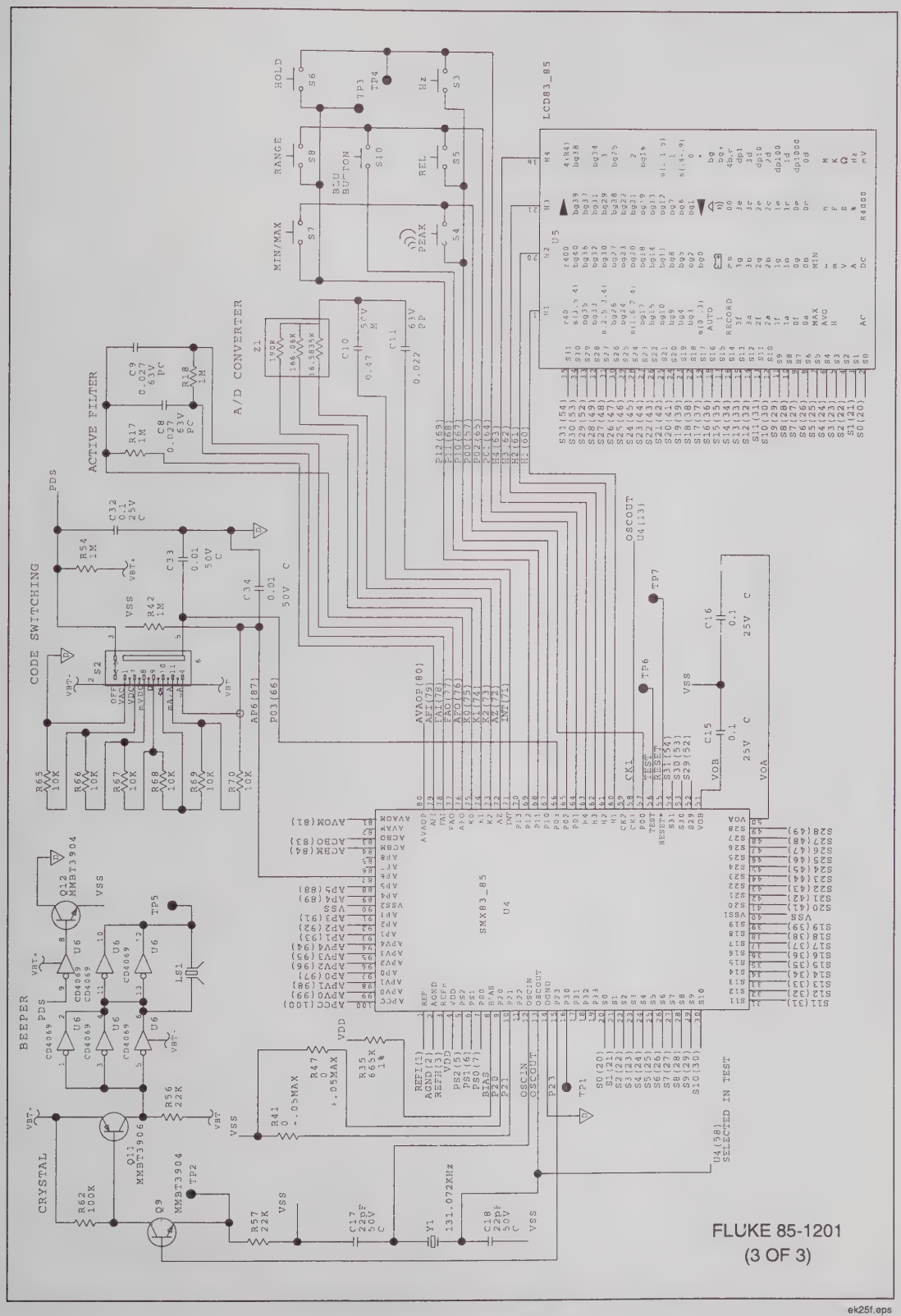

Figure 5-2. Fluke 85 A1 Main PCA (cont)

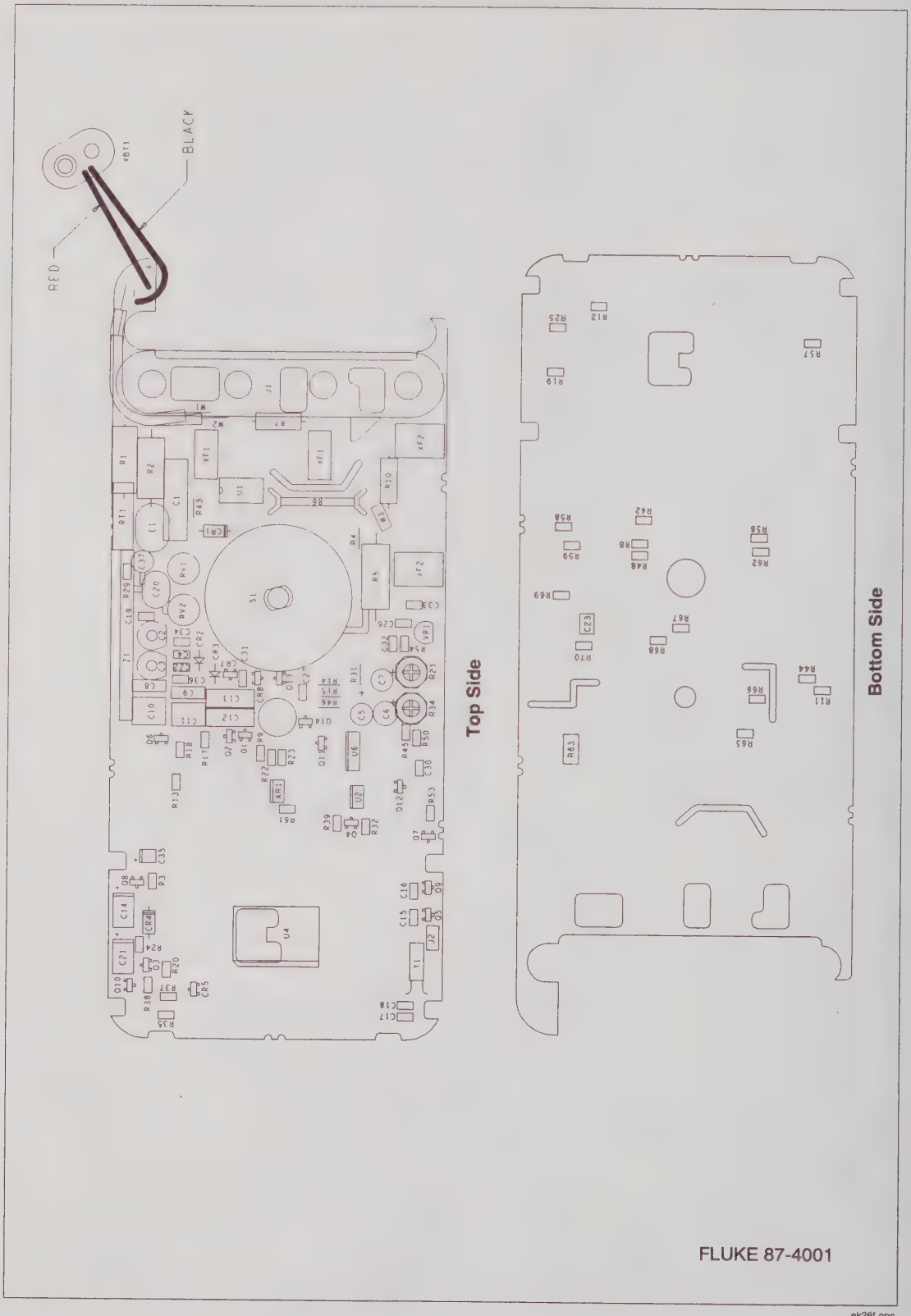

Figure 5-3. Fluke 87 A1 Main PCA

NOTES: UNLESS OTHERWISE SPECIFIED.

1. ALL CAPACITANCE VALUES ARE IN MICROFARADS. TANTALUMS ARE +/-20%. ALL OTHERS ARE +/-10%

2. ALL RESISTANCE VALUES ARE IN OHMS, 1/8 WATT,+/- 5%,CERMET. +/-.25% & +/-1% RESISTORS ARE 1/8 WATT.

ROTARY SWITCH INFORMATION			
POSITION	FRONT	REAR	TEST ROTARY SWITCH** +/-12 COUNTS
OFF		1-2*	
ACV		1-2	0
DCV	3 4	1-2	32
mVDC	3-4 11-12		64
Ω	3-4-5 11-12		96
→|←	4-6 11 12	1-2	128
mA/A		9-8 1-2*	160
uA	3-4*	10 9	192

*CONNECTION NOT USED FOR OPERATION
**POWER UP OPTION
PRESS RANGE BUTTON DOWN FOR 2 SECS WHILE TURNING ON METER

COMPONENT TYPE ABBREVIATION CODE			
SYM	CAPACITOR	SYM	RESISTOR
M	MYLAR/POLYESTER	MG	METAL GLAZE
C	CERAMIC	WW	WIRE WOUND
T	TANTALUM	MF	METAL FILM
PC	POLYCARBONATE		
PP	POLYPROPYLENE		

REFERENCE DESIGNATION			
LAST	USED		NOT USED
AR	1	AR	
BT	1	BT	
C	37	C	24,25,28,29 38,39,40
CR	8	CR	6
E	2	E	
F	2	F	
J	2	J	
LS	1	LS	
Q	14	Q	
R	70	R	16,21,26,27,28 30,33,36,40,41 47,49,51,52,54 60,64
RT	1	RT	
RV	2	RV	
S	10	S	
TP	7	TP	
U	6	U	3
VR	1	VR	
Y	1	Y	
Z	1	Z	
W	3		

FLUKE 87-1201
(1 of 3)

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Figure 5-3. Fluke 87 A1 Main PCA (cont)

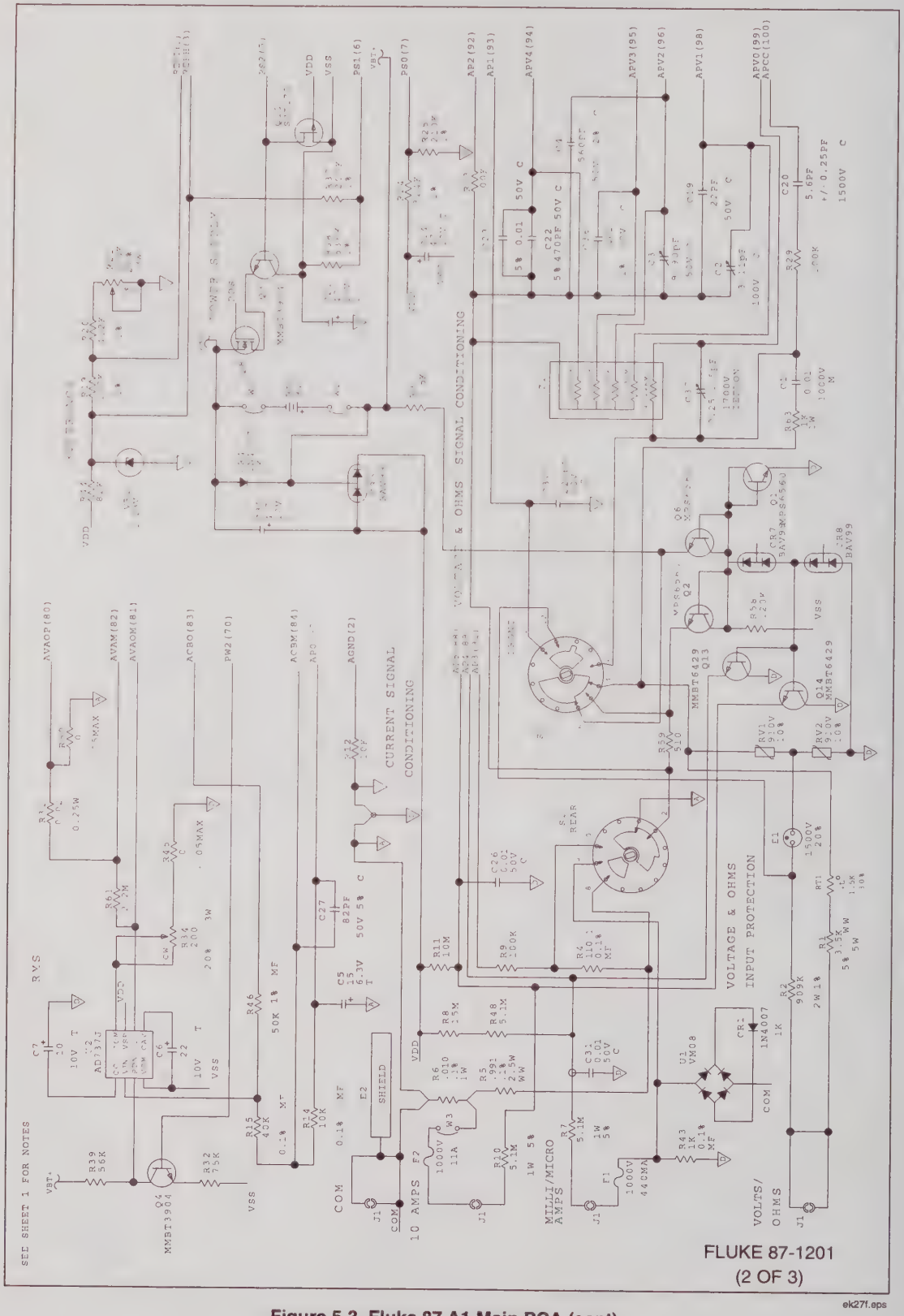

Figure 5-3. Fluke 87 A1 Main PCA (cont)

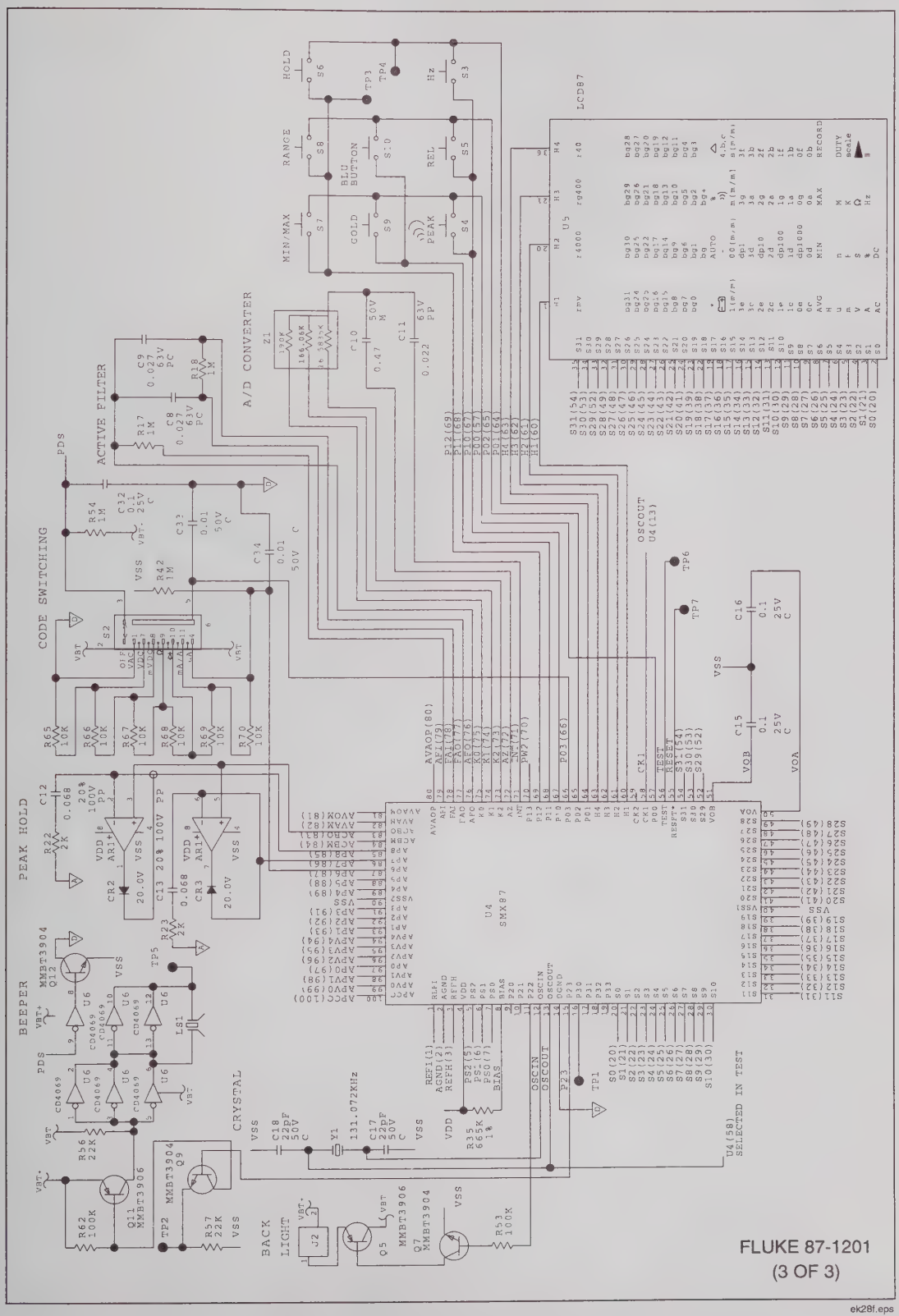

Figure 5-3. Fluke 87 A1 Main PCA (cont)

ACCOPRESS®

25970	YELLOW
25971	BLACK
25972	LIGHT BLUE
25973	DARK BLUE
25974	LIGHT GRAY
25975	LIGHT GREEN
25976	DARK GREEN
25977	TANGERINE
25978	RED
25979	EXECUTIVE RED

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